Population Pressure and Agricultural Development in Ethiopia: The Case of Arssi Region

A Thesis Submitted to the School of Graduate Studies
Addis Ababa University

In Partial Fulfilment of the Requirements for
Master of Science Degree in Demography

by
Dagnachew Kaleab

Addis Ababa
May, 1999

Population pressure and Agricultural
Development in Ethiopia:
The case of Arssi Region

by
Dagnachew Kaleab

Approval by Board of Examiners

Eshetu Gurmu
Chairman, Department
Graduate Committee

Signature

Tegegne G/Egziabher
Advisor

Signature

Dejene Aredo
External Examiner

Signature

SEYUM G. SELASSIE
Internal Examiner

Signature

ACKNOWLEDGMENTS

First of all I praise my God in Christ Jesus who has been accomplishing all my works in my hand. Indeed, this paper wouldn't have been materialized, had it not been for His marvellous help.

I am greatful to my advisor, Dr. Tegne G/Egziabher for his appreciable suggestions and supervisions from the very beginning to the end of the thesis work. I am greatly indebted to my friend Engineer Befikadu Kassahun for helping me to get in touch with workers of Arssi Zone Agricultural Development Office. I am indebted to Ato Mulugeta Tadesse for his appreciable cartographic work in this thesis. I am also thankful to my fiends, Aklilu Amsalu, Shambu and Getachew H/Mariam for their contribution in the thesis work.

I would like to thank W/t Fekerte Tulu for typing the paper patiently and diligently. I also extend my gratitude to W/ro Ketesal Mengistu, and my christian fellows who have been praying diligently for the accomplishment of the thesis.

Finally I thank the School of Graduate Studies, Addis Ababa University for its financial support to this study.

GLOSSARY OF LOCAL TERMS

Awraja	An intermediate level administrative unit (beyond the wereda level).
Enset	False banana plant. A Staple food crop in South Central Ethiopia.
Teff	Eragrostis teff, locally most important cereal crop in Ethiopia and used to make Injera.
Wereda	The lowest level administrative unit (equivalent to districts).

DEFINITION OF SOME TERMS

Carrying Capacity	Could be defined as the number of population that can be supported by a unit area of land with out irreversibly reducing its capacity to support people in the future
Farm	Refers to the total size of arable land operated by a farmer
Household	Persons who dwell in the same housing unit, work and have common arrangement for meals.
Plot(parcel)	is part and sub-part of one's crop land. A farm sually consists of a number of parcels or fragments.
Population pressure:	Refers to the situation where the population size exeeds the carrying capacity of rural lands. However, due to the absence of reliable data to estimate the carrying capacity of the rural lands the agricultural population density (i.e. the ratio of rural population to cultivated land) is sused as a proxy measure of population pressure.

Sustainable Development — Means a process in which the exploitation of resources in a country as well as the direction of these resources together with the orientation of technological development and institutional change are made consistent with the present and future needs of the country's population.

Technological Change — Refers to the change in which rural communiites change over from one kind of tool to another, e.g. from digging stick to hoe or from hoe to plough.

LIST OF ABBREVIATIONS

AISCO:	Agricultural Inputs Supply Corporation
ARDU:	Arssi Rural Development Unit
CADU:	Chilaho Agricultural Development Unit
CSA:	Centeral Statistical Authority
CSO:	Central Statistical Office
FAO:	Food and Agricultural Organization
GDP:	Gross Domestic Product
MOA:	Ministry of Agriculture
NRDC:	National Revolutionary Development Campaign
OPEDB:	Oromiya Planning and Economic Development Bureau
SEAD:	South East Agricultural Development Zone
SIDA:	Swedish International Development Authority

TABLE OF CONTENTS

List of Tables

LIST OF FIGURES

ABSTRACT

The main objective of this study is to examine the inter-relationship between population pressure and agricultural development in Arssi region. The basic data for the study were acquired from secondary sources.

Various descriptive statistics (percentages, means, standard deviations and coefficient of variation) together with simple correlation and regression methods were used to analyze the data.

The findings of the descriptive statistics of the study unfolded that farm size were small and varied among weredas. In general, land holding per capita of peasant farmers is probably to decrease under the present conditions. Here, it must be emphasized at this point that there is demographic reason for the prevalence of decreasing farm size (even though there are other factors responsible). In addition, there were yearly fluctuations (ups and downs) of yields (out put/ha) overtime.

Analysis of the data used in the study unfolded large spatial disparity in the levels of land and labour productivity at wereda and agro-ecological levels.

The regression analysis (cross-sectional data) has shown that the use of fertilizer has been the single most important variable explaining land and labour productivity. The remaining variables were not statistically significant.

According to the simple regression analysis (time-series data) at the aggregate level it was indicated that size and density of population had positive impact on changes in fertilizer usage, application of improved seeds, crop land and crop production. Here, the regression results lend some support for the Boserup's thesis regarding the relation ship between population density and agricultural intensification.

Finally the paper recommended the following policy measures. Among other things, increasing the cropping intensity (cultivating two or more crops per year on the same farm plot); the intensive cultivation of land per crop season through increased use of labour input; the minimization of dependence on cereals through the production of more labour intensive and high productive crops like enset; and large scale conservation practices could be mentioned.

CHAPTER ONE

I. INTRODUCTION

1.1 Background

Agricultural out put per capita has declined by about 15% since 1980 in the twenty- four sub-sahran African countries classified as the most highly affected nations (in food crisis) by the United Nations Food and Agricultural Organization (World Bank, 1984). Numerous factors could be causes to such declining growth of out put in these countries. Lack of inputs such as fertilizers, improved seeds, credit systems, macro and sectoral policies, over population are often cited as causes of Agricultural underdevelopment.

Population is an important factor in Agricultural development and under development. In many sub-saharan Africa, there are relatively too many persons in the Agricultural sector-producing too little food (in amount and quality) for the total population. The problem is generalized variously by terms like population pressure, acute poverty, or agricultural over-population. Agricultural over population is concerned with the process of deteriorating agriculture as a result of growing population with a static occupational structure (Leone, 1974). Increased population pressure results in reduced farm size, overgrazing and fragmented plots.

On the other hand, positive relationship between population density and agricultural intensity (measured through either the frequency of cultivation or out put per unit area or time) have been demonstrated for many parts of the world (Brush and Turner, 1987).

These two opposing effects of population on agricultural development are summarized by two theoretical perspectives. These are the Malthus theory and the Boserup theory.

Thomas Robert Malthus published his now famous "summary view of the principle of population" in 1830. The central theme of Malthu's theory was that population, when unchecked, would increase geometrically while the means of supporting it would increase only in an arithmetic rate. Hence, he predicted the emergence of a chronic imbalance between population and physical resources, with population growth rapidly out paces the means of sustenance even at substance level (Findlay and Findlay, 1987).

In Malthus' opinion, population growth is dependent variable determined by agricultural productivity. He argues that the provision of food for human being is in elastic, and that this lack of elasticity is the main factor determining the rate of population growth.

On the contrary, Boserup, a Danish economist, has postulated (1965,1981) a more optimistic hypothesis regarding the relation between population and physical resources. She realized several impacts of population growth on agricultural practices, like decline in fallow period and increase in annual multiple cropping, increase in land investments, and changes in the methods of cultivation.

Boserup asserts that growing population pressure induces technological change, leading to a more intensive system of agriculture and an increase in aggregate agricultural out put.

Unlike the Malthusian views, Boserup focused on questions of how population growth, affects agricultural production. Here, population is taken as independent variable and is positively correlated with the dependent variable which is technological development in agricultural production (Findlay and Findlay, 1987).

The extent to which Boserupian or Malthusian perspective applies need to be emperially studied as it has policy implications for population and agricultural development.

1.2 Statement of the Problem

It is an obvious fact that the Ethiopian economy is predominantly rural. Agriculture forms about 55 percent of the GDP, 80 percent of the employment and 60 percent of the exports (CSA, 1996). Agriculture in the Ethiopian economy has been the only most important variable in explaining the fluctuation (ups and downs) of aggregate economic performance over the years. The expansion of the economy and the improvement of the standard of living of the vast majority of Ethiopians are mainly influenced by the efficiency of the agricultural sector. Consequently, there is a need to investigate the problem of agricultural productivity which may in turn requires understanding of varying characteristics of Ethiopian Agriculture at large and regional farming systems in particular.

Out of the numerous factors that affect agricultural development in Ethiopia, population is one significant factor.

According to the 1997 world population Data Sheet (Demographic Data and Estimates for the countries and Regions of the World), the population of Ethiopia is estimated to be 58.7 million (mid 1997) with 2.8 natural increase (annual%) (Population Reference Bureau, 1997).

Population density is growing at a faster rate. The simple man/land ratio at national level increased from about 22 persons/km2 in 1975/76 to 33.6 in 1984 and 40.7 in 1989 (CSO/CSA, 1977, 1984, 1990). The estimated population density of the country increased to 45 persons/km2 in 1992 (Assefa et al., 1995). This may show that population density in Ethiopia is growing at a rate of about 1.4 persons/km2 per annum since 1984 (Muluneh, 1994). Rural density which is the ratio of rural population to cultivated land area, is about 250 person per km2 (CSO/CSA, 1984/1988).

Food production in Ethiopia has failed to keep up with the increasing population of the country for about 2 and half decades now. While the country's population is estimated to be increasing at the rate of 3% a year, the per capita and total crop yield levels are very fluctuating from time to time and continue on a substantially declining trend (Markos, 1997). Population pressure has resulted in reduced farm size, land fragmentation, over-cultivation, over-grazing, etc. There are also places in Ethiopia where rapid population growth has led people to practice different intensification methods. For instance, as it was reported by Muluneh (1994) in Ezana Wollene and Cheha woredas of Sabat-Bet Gurage land, population pressure is very high and arable land is scarce to allow any further expansion of cultivation. As a result, there has been the use of more labour in put per unit area, multiple - cropping, increased manure supply, reduction of the fallow period, increased cultivation of enset (which has high supporting capacity and less a real coverage) and the like.

The fact that the different responses are observed in Ethiopia begs for more empirical research at different levels of study. Empirical researches would ascertain which of the relation between population and agriculture consistently appear and which relation ships are not supported by empirical research knowledges on the relation ships, their strengths and weaknesses would form the basis for policy and strategies in the agricultural sector.

In light of the above observation, this study, by focusing on crop production sector at aggregate level, is intended to make some contributions to studies on population pressure and agricultural production in Ethiopia by taking the case of Arssi.

1.3 Objectives

The general objective of the study is to examine the interrelationship between Agricultural Development and population pressure in Arssi region. The specific objectives are:

1. To examine the nature and extent of agricultural development (change) in the region at wereda level.
2. To examine the levels and changes in population growth at wreda level.
3. To examine the relationship between population size and change and agricultural development in the region at wereda level.

In order to attain the above objectives, the following research questions will be attempted to be answered.

1.4 Research Questions

1. What are the nature and changes in Agricultural out put, cultivated land, in put use and different intensification and extensification methods in Arssi region at Wereda level?

2. What is the change of population size in the region as indicated by rural density, migration etc?

3. What are the roles of levels and changes in population size in determining agricultural development i.e farm size, agricultural output, input use and different intensification methods?

1.5 Justification

The study area for the research is Arssi region. The reasons for selecting Arssi as a case study are the following:

1. According to the 1984 population and housing census results, Arssi had a total population of 1,622,790 which is much greater than the 1965 government estimate of 1,068,800. This increase is about 55.58%. The population of the region rose to 2,217,245 in 1994 (CSA, 1994). In 1992, the estimated crude population density of Ethiopia was 45 p/km2 while that of Arssi was 88.2 p/km2 indicating the above average status of population density in the region (Assefa et al., 1995). Arssi therefore represents one of the areas where the effects of population pressure on agriculture can be studied objectively.

2. Arssi is one of the few surplus cereal-producing regions in the country. As far as food availability per capita is concerned, the region stands first as a surplus producing area. It is also believed that the region is typical of the Ethiopian highland in terms of its climate, topography and the kind of agricultural practices (Amare, 1995).

3. Moreover, the fact that Arssi had the same Administrative reclassification both in the 1984 and 1994 population and Housing Censuses, permits us to obtain a more comparable and consistent data at least at a regional level.

1.6 Data and Methodology

1.6.1 Sources of Data

In order to achieve the above objectives, secondary sources of data will be used in the research. These data will be mainly obtained from the 1984 population and Housing census (Analytical report on Arssi region) and the 1994 population and Housing census (Result for Oromiya Region). These sources contain socio-demographic data consisting of information on economic activity, education, fertility, etc.

The other sources of data for this study are MOA General Agricultural Surveys and CSA Annual Agricultural Sample Surveys.

In addition to the above stated sources, unpublished data will be collected from zonal MOA, and planning Offices.

1.6.2 Method of Data Analysis

The units of analysis for the study are both the weredas and the region. Most of the analysis pertain to the weredas wherever data are available and other analysis are done at regional level. Various descriptive statistics (percentages, means, standard deviation, and coefficient of variation) will be used to summarize the trends and patterns of population and Agricultural development.

Simple correlation and regression methods will be used to examine the strength and direction of association which exist between population and indicators of agricultural change (including average land holding per household, changes in the land use pattern, land productivity, labour productivity).

1.6.3 Limitation of the Study

The study is limited mainly by the lack of time series data on various indicators. The study needs time series data for many years. But availability of such data from secondary sources alone is incomplete for there are multitude of factors that affect agricultural development in addition to population variables. Even the available data are some times of low quality and from different sources which could lead to data inconsistency. The different administrative reclassification of the weredas between the 1984 and 1994 population and Housing Census is also another limitation which creates some problems in terms of data consistency and comparability for district level study.

Moreover, the limited type of data on migration, especially lack of data on analytical report for the region for the 1994 census is also part of the limitation of the study.

1.7 Organization of the Thesis

The thesis is composed of seven chapters. The first chapter is introduction which deals with the general background of the research, statement of the problem, objectives of research, research questions that are attempted to be answered, justification, and data and methodology. Chapter two focuses on summary of related literature. In chapter three, general background information on Arssi is discussed. Chapter four examines farming system in the region. Chapter five investigates population size, growth and distribution. Chapter six is devoted for discussion on the relation between population growth, patterns of agricultural productivity and attributable factors. Finally, summary of findings, recommendations for policy, program interventions and future research needs are presented in chapter seven.

CHAPTER TWO

II. REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK

2.1. Population Pressure and Agricultural Development.

Most of the population in the least developed countries (LDCs) like Ethiopia resides, works, and consumes in agricultural areas. Today, there is a tendency in modern development studies to give more focus on agriculture as the foundation of national economic growth in these countries. The knowledge about the impacts of population growth on agricultural production is of a paramount importance due to the complex relationship that both exhibit.

While there is a general understanding that rapid population growth and consequently high population pressure have been the basic factors behind land use changes, the manner and direction of linkages have not been investigated in detail. There has been few research that systematically analyzes the relationships between population pressure and growth on changes in agricultural practices. For instance, a recent article by Bilsborrow and Geores(1994) focuses on an entire lack of research in this area. After reviewing the available literature on the relations between population and agricultural practices, Bilsborrow and Geores write,

> "...existing knowledge of these relationships is almost entirely a descriptive, ad hoc nature. ... While dramatic changes in agricultural methods are occurring in many areas of developing countries, their possible relationship to population factors has been examined hardly at all. ... there has been particularly no research on the relationship between demographic processes and the use of chemical fertilizers or other

modern chemical inputs. ..."(Bilsborrow and Geores 1994:171, 185, 186 cited in Mishra,1996).

Similar ideas about lack of research on this subject are also mentioned by Vosti et al.(1994), Turner et al.(1995), and Bilsborrow and Geores(1993), among others.

Different World bank projections show that if past trends of population growth and food production persists, the gap between Africa's food production and consumption will increase rapidly in the coming decades. It is expected that the economy of a country should grow three times the rate at which the population is growing for a sustainable development and achieve the same standard of living (Ominde and Ejiagu,1981).

It is asserted by some writers that regions with higher population growth some times have higher yields per hectare of cultivated land. Some of the mechanisms by which population growth may result in higher productivity is through intensive cultivation of land, i.e., by greater labour utilization, resulting from greater availability of labour per unit of land, bringing more fallow land under cultivation and changes in agricultural practices. (Boserup, 1965, Chaudhury, 1981).

Among other things, multiple cropping is one of the indicators of the level of intensification and agricultural technology which is caused by the effect of population growth on land use. It is concerned with increasing production through intensification of cropping in terms of time and spatial dimensions; growing two or more crops on the same land. This type of agricultural practice is well known in China and India, together with in parts of-sub-saharan Africa, and is one of the most significant mechanisms of increasing food production (Seyfu, 1989).

The situation in China is worth mentioning in some detail. Perkins (1969) examined the development of agriculture in China over a period of Six centuries, and also reviewed evidence regarding earlier evolution. China is of special interest due to the fact that during the last millennium or two it has evolved from an area of low population density (population per hectare) to one which perhaps has the highest density of any large, non-insular region. Hence, China represents the evolution through all five systems of increasingly intense land use. Prior to the fifth century A.D. the common forms of agriculture were Slash and burn, Shifting cultivation (i.e.; forest-, bush-and short-fallow cultivation, using Boserup's terminology), concentrated in the Yangtze River region (Perkins, 1969). As population increased, people went for a permanent settlement and annual cropping slowly became pre dominant. As the population continued to increase during the last Six centuries, annual cropping has been substituted increasingly by multiple cropping and other forms of land intensification.

In India, the population increased by a factor of about 2.5, from 357 million to 846 million between 1951 and 1991. Despite this rapid growth in population, the country has made tremendous progress in food production. Food production increased almost three-fold and per capita net availability of food grains per day increased from less than 400 to 510 grams. The growth in agricultural production is mainly due to increases in multiple cropping, area under irrigation, and use of chemical fertilizers, and the introduction of high yielding seed varieties (Mishra, 1996).

Even though net sown area in India has ceased to expand for more than two decades, gross cropped area continues to grow at a modest rate because of increase in multiple cropping. This growth in cropping intensity has made India achieve high level of agricultural productivity (op cit).

In addition, population growth may also determine the type of crop grown. In China, for instance, there was modest substitution of rice for other grains (millet and kaoling) and introduction of new crops, particularly corn (beginning in the 16th century but mainly important since 1914).Their importance was their much higher yields. Similar evidence can be observed in Africa today where cassava has substituted traditional yams. These changes were all stimulated by the increased population per unit of land (Perkins,1969; Grigg,1980).

On the other hand, some recent research findings on Ethiopian agriculture show the negative consequence of population growth. Abbi (1995) for example, argues that population growth accompanied by increased food demand leads to increased land fragmentation and intensive use of land. As a result, cultivation will be persistent and, fallow periods will be too short to allow soil to regenerate. Therefore, population pressure impedes agricultural development by aggravating the land degradation problem. A study in Arssi region, particularly in Chilalo "awraja" or district (based on farm level data) also suggests that as demographic pressure increases through time (already one of the regions with the highest population densities), more farmers will be moved to operating at high risk of guaranteeing their basic subsistence (Amare, 1995).

In the country, after the 1975 Rural Land Proclamation, the land redistribution policy has indicated the growth of family size as the main cause of fragmentation, and in the view of some researchers the problem of fragmentation has been worsened in the post-reform period(Fasil,1980; Mengistu, 1986; Mesfin, 1986). This coupled with the decline in the size of individual plots due to population growth, has had an adverse impact on productivity. According to the Ministry of Agriculture, the average farm size declined from 1.9 hectares in 1974/75 to 1.3 hectares in 1983/84, which is a reduction of almost 30% in less than ten years (MOA, 1984). Peasant holdings are generally very small, the nation-wide average being about one hectare per farmer. Moreover, the land allotted to households is of "small" size (Teshome, 1992).

Land fragmentation has been one of the principal causes for inefficiency and wastage in peasant agricultural production. It results in many problems such as wastage of time in moving from one plot to the other one, inconvenience in using modern machinery, and uneconomic use of both man power and land resources.

The negative influences of land fragmentation on agricultural production are associated with the problems of using irrigation, weed and pest control, crop rotation and overall agricultural innovations. Moreover, land is used up for making more boundaries, paths, and drainage channels. The problem of land fragmentation raises with the increase of the distance of farm plots from the peasant's homestead.

Generally fragmentation makes cultivation ineffective and modern management impracticable. Nevertheless, in the face of a hostile physical environment, it could be used as a risk-aversion method. For instance, if one field is hit by a hail storm, there is a possibility for another field to remain safe (Dejiene, 1986). It could also be taken as a poverty alleviation mechanism in a district with increasing population pressure on resources.

It has been found that about three-fifths of the total holdings in Ethiopia consists of two or more parcels of land scattered over wide areas (Dejene, 1986).

The quality of land is the cause of farm fragmentation during the redistribution of land among the peasants. A farm household is provided with a portion from each type of land, usually classified as fertile, semifertile, poor quality, low land and upland (Mulat, 1989).

The effects of population pressure on agricultural development are summarized by two opposing theoretical perspectives. These are the Malthus theory and Boserup's theory.

2.1.1. The Malthus Theory

Thomas Robert Malthus published his now famous "Summary view of the principle of population" in 1830.In his book he argued that population growth is the prime and inevitable cause of poverty, starvation and misery.

The central theme of Malthus' theory focused on two principles:

1. Population, when unchecked, would increase geometrically.

2. Production from land, which is the means of supporting population, would increase only in an arithmetic rate (Findlay and Findlay, 1987).

In Malthus' opinion, population growth is dependent variable determined by agricultural productivity. He argues that the provision of food for human being is inelastic, and that this lack of elasticity is the main factor determining the rate of population growth.

Malthus asserts that there must be checks that curb population growth for it rapidly outpaces the means of sustenance even at a subsistence level. He proposed two types of checks: These are preventive and positive checks (Findlay and Findlay, 1987).

The preventive checks include abstinence from marriage or delayed marriage and the like in order to reduce fertility rate. The positive checks include disease, famine, war, vice etc.

In Malthus view the increase in population, which is not in harmony with the carrying capacity of the land (chronic imbalance between population and physical resources) must result in the elimination of the surplus population either by direct starvation or by other positive checks.

Malthus' theory has been criticized for failing to recognize and foresee the role of technological advance and modern economic development in the world. The Malthusian views that population growth is the primary cause of poverty and under development is now controversial (Boserup, 1965).

In recent years much has been discussed on the issue of "population problem". It is suggested by the Neo-Maltusians that the underdeveloped nations these days are in a "population trap" and that "Over population" happens to be a major hindrance for them in their efforts to get out the "Vicious circle of poverty". It is stressed in the Neo-Malthusian literature that the future pattern of social and economic development in the countries of the Third World will be determined mainly by demographic factors. In some quarters ("Club of Rome" for example) Malthusian fears of imminent doom and destruction by the abundance of babies has been worsened by the "rising expectations" of the Third World(Saigal, 1973/74). Fright has been expressed on the basis of world population projection that unless the so called population explosion in the Third World is curbed and economic growth of the world as a whole is slowed down, exponentially increasing population and industrialization will in the short run exhaust the supposedly finite store of natural resources, the capacity of the biosphere to absorb pollution, and the possibility of mass starvation caused by dwindling provision of the arable land (op cit).

Such a view has been widely popularized and population growth has come to be considered as a major hindrance to economic development. Recently, several of the governments of the Third World have accepted the Neo-Malthusian view and look to steps of birth control as a resolution to their social and economic difficulties. By 1970, twenty seven countries of the Third World had set in their development plans or specific programs or general targets for reduction, through birth control measures, of their population growth rates; many other countries, while they have not identified any targets, actively support population programs for controlling birth rates. While it is universally understood that the continent of Africa is the most sparsely populated except Oceania and that it is one of the richest continents in the world in natural resources, most African countries (such as Kenya, Tunisia, Morocco, A.R.E.; Ghana, Nigeria, Mauritius, etc.) have accepted the Neo-Malthusian view and consider population growth as an impeding factor to rapid economic development (op cit.).

According to the popular opinion promoted by the Neo-Malthusians, it is the increase in the population of the LDCs that casts dark shadow on the future prospects of international development.

The reasoning of the Neo-Malthusians can be generalized in the following two propositions:

1. The earth's non-renewable resources, capacity to absorb pollution, and arable land to provide food have a finite limit. On the contrary, our planet is currently experiencing an unprecedented pace of demographic expansion. Thus, if the world population persists to increase at the present rate, there will be a danger of absolute overpopulation with respect to food supply, environment and natural resources required for industrial progress and in relatively near future this may cause sudden drop in population and industrial capacity ("Malthusian doom").

2. A high population increase in the countries of the Third World, as experienced in recent years, poses a serious threat to their economic development. The reasoning of this proposition runs as follows. A high population increase resulting mainly from a reduction in mortality both infant and adult-increases, on the one hand, the dependency burden on the adult population involved in production (effect of the decline of infant mortality) and on the other hand, increases the potential labour force

seeking job opportunities and other supporting services (effect of the decline of the adult mortality i.e. more adults living longer). While the former, according to Neo-Malthusians, results in increased consumption and reduces the capacity of the society to accumulate and hence slows down potential economic growth, the latter aggravates already existing widespread unemployment and underemployment in the LDCs. In a nutshell, it is suggested by the Neo-Malthusians that the population growth causes "poverty" and "underdevelopment" in the countries of the LDCs because "it is becoming increasingly hard to raise living standards and maintain even the current quality of life in the face of these, huge annual growths in population" (op cit.). In other words, according to the Neo- Malthusian thesis, the LDCs are presently in a "population Trap" and so the solution to their economic and social problems is the adoption by them of birth control measures.

2.1.2. Boserup's Hypothesis.

Boserup, a Danish economist, has postulated(1965) a more optimistic hypothesis regarding the relation between population and physical resources. She has suggested that population growth, rather than being an obstacle to economic growth, is actually a pre-condition for agricultural development. Her hypothesis is formulated on the basis of a close examination of the history of agriculture in general and the evidence of prevailing Third world agricultural practices in particular. Boserup's empirical data for her appreciable model were obtained from community studies in LDCs.

Unlike the Malthusian views, Boserup focused on the question of how population growth, in turn, affects agricultural production in contrast to agriculture limiting population growth. Here, population is taken as independent variable and is positively correlated with the dependent variable which is technological development in agricultural production. The human response to land scarcity is reflected in the adoption of more productive tools which are used to intensify land and labour usage (Findlay and Findlay, 1987).

She argues that Malthus didn't recognize the successive stages from shifting cultivation to permanent agriculture from digging stick to ploughs when he formulated his theory.

In accordance with Boserup's (1965) analysis, population growth has eight prominent impacts: 1, It decreases the fallow period; 2, it demands additional investment on land; 3, it stimulates the shift from hand-hoe cultivation to animal traction; 4, it induces soil fertility maintenance through manuring; 5, it decreases the average cost of infrastructure; 6, it allows more specialization in production activities; 7, it decreases a change from general to specific land rights; and 8, it decreases per capita share of common property resources (Lee, et al; 1991).

Boserup sees population pressure as a principal cause of changes in agricultural technology, land use, land tenure systems and settlement forms. She stresses that the principal means by which peasants increase their agricultural production is through intensification*.

---

* Land intensification according to Boserup(1965) implies decreased percentage of land fallow, increased percentage of land under irrigation and increased multiple cropping (more than one crop per year on the same land).

Boserup's thesis is based on the premise that subsistence farmers are labour-efficient and will choose the intensity of cultivation that will satisfy their agricultural needs with the least amount of work. Extensive systems of agriculture maximize labour efficiency in circumstances of low population density. Due to the fact that total production in such systems is low, extensive cultivation can not support high population densities.

Hence, Boserup advocates that an increase in population pressure is the key factor that governs a shift from extensive to intensive systems of cultivation. She could be criticized on this point, i.e., to emphasize on population as the sole major determinants of agrarian change. Nevertheless, her recognition that innovation could be induced by rural population growth is not questionable, and this is one of her major contributions to the literature.

In her classic work, Boserup(1965) identified five stages or systems of increasingly land-intensive farming technology, each of which is distinguished by higher labour inputs per unit of land; forest or long fallow (25-35 years between crops); bush fallow (6-10 years); short fallow (1-2 years); annual cropping; and multiple cropping. As population increases, societies move from forest or long fallow to multiple cropping, each step indicating an increasingly more intensive land use technology (Boserup cited in Bilsborrow, 1987). Boserup's model shows that as rural population density grows the fallow area is gradually reduced and finally eliminated entirely. With the change in the fallow system, there is inevitable change in agricultural techniques. As the system of agriculture is intensified, the land needs more thorough preparation and hence substitution of the digging stick by the hoe, which in turn is ousted by the plough (Boserup,1965). Moreover, as the length of the fallow is reduced, it becomes essential to maintain soil fertility using new methods. The method of fertilization thus changes from ash fertilization in situ (by burning of natural vegetation) to the application of manure (op cit). Boserup's original evidence advocating her thesis of a positive relationship between population pressure and agricultural intensity was obtained mainly from studies of tropical subsistence agriculturists. Nevertheless, her more recent career investigates the evidence of the relationship between population density and agricultural technology in many LDCs (Boserup, 1981). Her cross-country evidence unfolds a negative tabular relationship between ratios of pasture land to arable land and population density. She recognized the expansion in arable land to have come at the expense of land under permanent pasture and forests, the reduction in the latter, being because of increasing population density. She also mentions data showing a positive relation ship between the estimated percentage of land under multiple cropping and population density, implying a close relationship between rural population density and the extent of multiple cropping (Boserup, 1981).

On the basis of Boserup's hypothesis (1965, 1981) and Kingslay Davis' (1963) "theory of demographic change and response", Bilsborrow (1987) presents a wider theoretical framework for investigating the effects of population change on agricultural development in rural areas of developing countries. He suggests multi-phasic responses to increases in population density, like land intensification through multiple cropping, irrigation, fertilizer, and pesticide use, land extensification, delayed marriage, contraception, abortions, increased abstinence, and net out migration. He focuses on the role of socio-economic and institutional factors in determining the nature of such responses. Like Boserup, Bilsborrow was in favor of a positive role of population in inducing land-use change.

Several researchers have used her views of the inter relationship between population growth and agricultural production in studying farmers in various parts of the developing world.

Rigg (1986) in his study on innovation and intensification in two villages in N.E. Thailand investigated that population growth had obliged farmers to use new ways of increasing production that supports Boserup's theory which states that population growth induces innovation to cope up with pressure of people on land.

Other studies have also identified that population pressure has a positive association with the level of agricultural intensification. Kumar (1973) in his analysis of country-level data identifies that high agricultural density, brought about by increasing population, leads to more intensive cultivation of land rather than land abandonment and migration to urban areas.

Turner et al. (1977) in a cross-sectional study of 27 population groups in 10 countries came across a strong positive relationship between population density and agricultural intensity, after controlling for the length of dry season, soil quality, and livestock availability. In a historical study of population growth, agricultural productivity, and land degradation in Machakos district in Kenya, Tiffen and Mortimore (1992) and English (1992) investigate that after the second World War, rapid population growth in the district has been accompanied by improved food production. Bilsborrow and Geores (1993,1994), from their analysis of the country-level data for 1960-80's, find a weak but positive association between population growth and changes in irrigated area and fertilizer use.

A recent study by Heilig (1994), using FAO data for 180 countries, also observes a weak association between population growth and land use changes during the period 1961 - 1991. While placing varying focus on the role of population, all of these studies find a positive association between population and land intensification, as suggested by Boserup and others.

Nevertheless, some recent studies have shown that Boserup's hypothesis may not work under certain circumstances. In a review of population pressure impacts on land intensification and environment in six sub-Saharan African countries, Lele and Stone (1989) question the appropriateness of Boserup's hypothesis by indicating that higher population densities do not necessarily give rise to better inputs and higher yields, particularly in resource-poor areas. Cleaver and Schreiber (1992), in a more recent research of 38 sub-Saharan African countries, concluded that in sub-Saharan Africa a "population, agriculture, and environment nexus" exists in which the influences of population growth, stagnation in agriculture, and environmental degradation are mutually reinforcing. Dasgupta (1992) also argues that Boserup's theory may not work under conditions of extreme poverty and highly degraded environment. According to him, in such conditions, people get caught in a "Vicious Cycle" of poverty- population growth-environmental degradation-poverty.

It is obvious from the above discussion that much of our understanding about the applicability of Boserupian model and the role of population factors in inducing agricultural intensification is dependent on some what descriptive, cross-sectional, country-level studies.

In connection with this, the general belief that rapid population growth yields in agricultural intensification mainly relies on measures like delivery of agricultural inputs to maximize production. The roles of these inputs in agricultural development in general and their status in Ethiopia in particular are discussed below.

2.1.3. Agricultural Inputs

Agricultural production can only be raised if one applies improved or modern techniques or methods on farms. The methods by which farmers sow, cultivate, harvest and maintain their livestock need to be changed and advanced with time.

One of the several reasons for the low productivity of agriculture in LDCs like Ethiopia is the scarcity or too low usage of yield raising inputs such as fertilizers, improved seeds and pesticides.

In accordance with a research conducted in a wereda of Northern shoa, modern factor inputs in general and fertilizer use in particular are little recognized by the peasants (Tessfaye, 1990).In contrast, Solomon argues that although it seems at present the majority of the peasants in Ethiopia are aware of the availability and application of this essential agricultural input(fertilizer), little is known as to why noticeable regional variations exist in the level of fertilizer use in the country(Solomon,1990).

The use of fertilizers by peasants has begun as early as the formation of the extension program in 1952.Nevertheless, because of an array of problems it has not gained strong foot hold as is expected. In sum, it is now more than three decades, since farmers particularly in Arssi and Shoa regions have begun to use fertilizer. During this period, awareness of fertilizers as an input to raise yields has become widespread among farmers and consequently, the demand together with the coverage for this agricultural input has increased substantially. Farmers have also learnt much about fertilizer application from their wealth of experiences in addition to the extension advice given to them.

In accordance with a General Agricultural survey of Ministry of Agriculture, 47% of the total number of farmers in Arssi, 24% in Shoa, and 16% in Gojam use chemical fertilizers as compared to that of the national average of about 13% (MOA, 1984).

Fertilizer is one of the modern agricultural inputs which can contribute to the improvement of agricultural productivity, especially in countries like Ethiopia where there is ecological degradation which tends to depress crop production. Without modern inputs it is unlikely that the present system of agricultural practices can meet basic food needs of the nation's growing population.

Improved seeds are very essential in increasing agricultural productivity like fertilizers. The Ethiopian Seed Corporation(ESC) which was formed in 1978 is responsible for the provision of improved seeds in the country.

It has been found that Arssi is the only region that applies improved seeds on a considerable scale(MOA,1984).

The other important modern factor inputs which are applied in Ethiopia for different purposes including agriculture are pesticides. It has been found that there is a desperate shortage of pesticides in the country and size of the imported package is another problem of the peasant to buy the pesticides individually. This influences peasant agricultural productivity.

2.1.4 Conceptual Framework

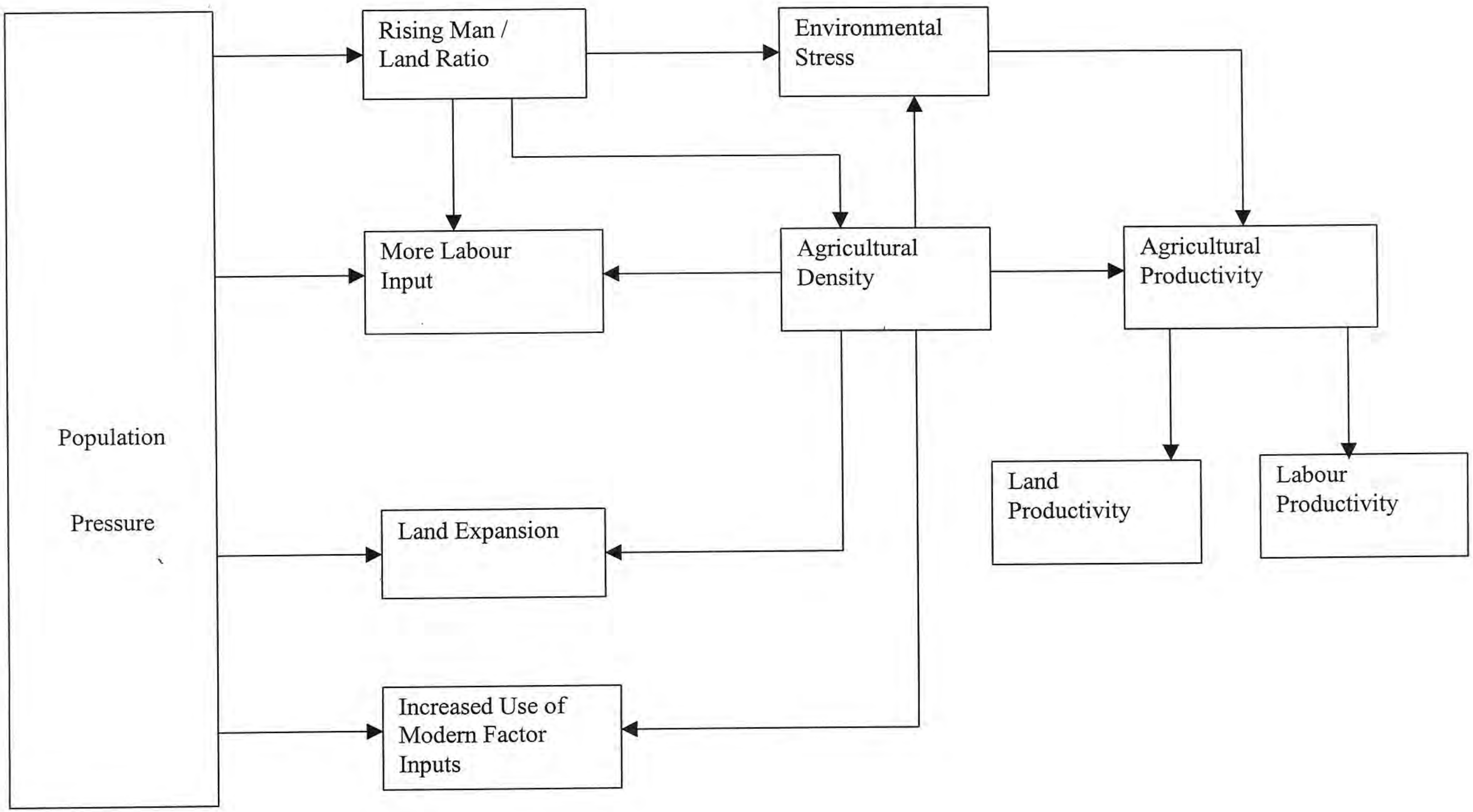
A conceptual framework of interrelationship between population, land pressure and agricultural development for an agrarian country like Ethiopia is shown in figure 1. The most serious stress caused on the environment in Ethiopia is associated with land degradation. The land resource which constitutes the basis of economic sustenance is degrading and loosing its productivity very fast. On the other hand, the population that depends on the land resources is growing very rapidly. This exerts high pressure on the land resource.

Population pressure causes high man/land ratio which in turn leads to high labour in put. High man-land ratio also necessitates that the land has to be used more productively to support the increasing population pressure. Increased use of modern factor inputs is one response that may result from the situation. The other responses to population pressure are manifested in the expansion of cultivation to ecologically fragile areas, deforestation, over cultivation, overgrazing etc. These responses inturn exert negative influence on the environment such as accelerated soil erosion and low agricultural productivity.

In traditional agricultural practices, population growth is often one of the main causes of environmental degradation. To meet the ever increasing demand for fuel wood, pasture and arable land, trees are cut down. Cultivation expands to the steeper slopes and to marginal lands with high erosion risks. The need to feed the increasing population also decreases the frequency of fallowing, which impacts adversely the fertility of the soil.

Agricultural productivity in this system is affected as a result of these interactive factors, i.e. the rising man/land ratio, land expansion, use of more labour input per unit area, intensified use of modern factor inputs and environmental stress (which could lead to soil degradation problems that tend to depress agricultural productivity).

Fig. 1. Population, Land Pressure and Agricultural Development



CHAPTER THREE

III GENERAL BACKGROUND OF THE STUDY REGION

3.1 Physical Aspects of the Region

3.1.1. Location and Size

The Arssi region is located south-west of Ethiopian's capital City, Addis Ababa. It covers an area of 23,674.7 km2 (statistical Abstract, 1995). Arssi is bounded on the north-west by eastern Shewa, from which it is separated by Awash river, on the-north-east by western Hararghe and on the South-east by Bale region. The region is separated from Bale by the Wabi Shebele river. The Southern Nations, Nationalities and peoples' Region (SNNPR) lies south of it. Its whole western and northern border extends along the lakes region upto the Awash station.

Previously, the region was divided into three Awrajas namely Chilalo, Ticho and Arbagugu which was further sub-divided into 22 weredas. But currently Arssi is divided in to 20 weredas (see Figure 3.1). Arssi is one of the 12 zones of the Oromiya region.

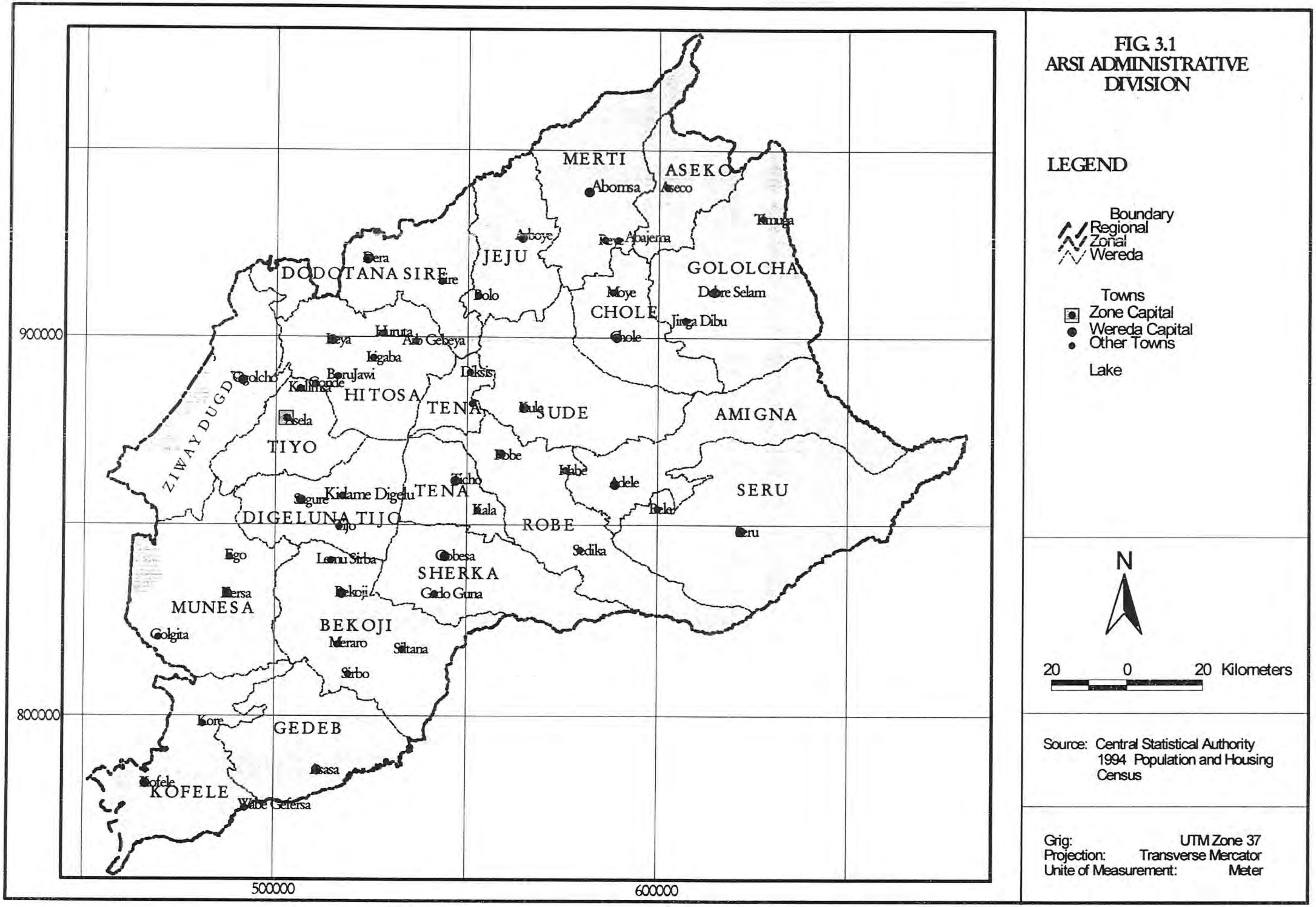


FIG. 3.1
ARSI ADMINISTRATIVE
DIVISION

3.1.2 Climatic Conditions

3.1.2.1. Rainfall Distribution

There are three seasons in most parts of the highland areas of Ethiopia, including Arssi. These include "the dry season" (Bega, November to February), "the big rainy season" (Keremet, June to September), as well as "the small rainy season" (Belg, February to May). With the exception of the dry low land areas in eastern Arba-gugu, the rest of Arssi receives sufficient amount of rainfall and so is well suited for rain-fed production of wheat, barley, teff, maize, peas, beans, pulses, and oil crops. Arssi is one of the dominant surplus cereal-producing regions in the country (Alelmneh, 1987).

Arssi receives its rainfall from two sources. The main rain fall received during summer (Keremt) from June to September originates from the Equatorial Westerlies that comprises about 58.98% and the second one, which accounts for 29.52% comes during the Belg season (February to May) originating from the Indian ocean. The remaining 11.5% of the total rainfall comes during October to January. Therefore, Arssi receives its highest amount of rainfall during the main season (June, July, August and September).

The region has a reliable rainfall which permits agricultural practices. The average annual rainfall for the region is about 1008.6mm (see Appendix 1).

3.1.2.2. Temperature

In the region, temperature varies from place to place. This is attributed to the effect of altitude. The mean annual range of temperature is higher for stations along lower altitude. For example, Abomsa station found at 1800 meters above sea level has 4.7oC mean annual range of temperature as compared to Degaga at 2787 meters above sea level altitude has 2.9oC annual range of temperature (Kebede, 1996). The mean monthly temperature is also higher for stations located at lower altitude.

The hottest months of Arssi are May and April while the coldest months are October, December and January (NRDC, 1983).

3.1.3 The Main Agro-Ecological Zones

According to altitudinal classification, three ecological zones are identified in Arssi (Alemneh, 1987). These are:

1. Highland (Dega) (beyond 2,400 meters);
2. Medium Altitude (Woina dega) (ranging from 2000 to 2400 meters)
3. Lowland (Kolla) (less than 2000 meters)

The above categorization is complicated by the great diversity in ecological zones in areas which are in close proximity to one another, and at times even in the same peasant association.

About 1/3 of Arssi region is in Kolla zone and 2/3 of it are under woina Dega and Dega zones. The percentage of land of Arssi weredas in each agro-ecological zones is reported in Table 3.1

Table 3.1 Agro-Ecological Zones and Weredas in Arssi

Weredas	%lowlands (Kolla)	%Medium Highlands (Weina Dega)	% Highlands (Dega)
Tiyo	11	52	37
Hetesa	20	48	32
Dodota-Sire	61	24.5	14.5
Zawi-Dugda	100	-	-
Digelu-Tijo	-	3	97
Munessa	8	42	50
Lemu-Bibilo	2	9	89
Shirka	35	37	28
Gedeb	-	65	35
Koffele	-	2	98
Sude	19	73	8
Robe	10	50	40
Tenna	14	19	67
Amigna	79	21	-
Seru	65	33	2
Jegu	20	47	33
Merti	55	26	19
Cholle*	22	18	60
Aseko	14.8	57.2	28
Gololcha	75	25	-
Total	32.1	34.2	33.7

Source: Rural Development Project in Arssi and Bale Project Co-ordination Office: The Extension System in Arssi Zone: Draft Report, January 1998, United Nations Office for Project Services

* In Cholle wereda, the 60% Dega zone consists of 12% "cold area" and 48% proper Dega.

3.2 The People of the Region

The dominant ethnic group in the region is the Oromos. They account for 81% of the population (60% Arssi Oromos and 21% Shoa Oromos) while 17% are Amharas. The indigenous population of the Arssi region are the pastoral Arssi-Oromos. Out of the total population, about 61% are Muslims and 39% Christians (Alemneh, 1987). All of the Arssi Oromos are Muslums while all Amharas and several of the Shoa oromos are Christians. It was in the 1880S that Emperor Menlik brought the region under the rule of Imperial Ethiopia. Motivated by the government's granting of land to new settlers, and the information about the region's fertile soil, the Christian Amharas and Shoa Oromos from the north began to settle in Arssi in large numbers. Hence, the process resulted in making most of the Christian Amharas land owners in fertile highland areas and Arssi Oromos tenants on their tribal land, while others migrated to settle in the sparsely populated lowland areas. Improvement in road transport after 1945 substantially increased the rate of migration and much of the grazing land of Arssi Oromos was taken over by the settlers for cultivation.

The phenomenon of migration both in and out is not unfamiliar in Arssi. On one hand the fertile nature of its soil, the centrality of its location and the foreign investment component have been operating as "pull" factors to attract migrants from other regions. On the contrary, the development of commercial farming was serving as "push" factor forcing the poor peasants with small holdings to migrate to neighbouring regions.

CHAPTER FOUR

IV. SYSTEMS OF FARMING IN ARSSI REGION

It is clear that farming system is identified and characterized by patterns of cropping and livestock raising and consequently by the land-use system of an area. In addition, farming system is supposed to be characterized by individual functional units of a farm like farm operations and management including the technology applied and institutional set ups (Muluneh, 1994).

According to Westphal cited in Amare (1995) four agricultural systems can be identified in Ethiopia. These include: the Seed-farming complex, the ensat planting complex, shifting cultivation, and the pastoral complex. The Arssi region is part of the seed-farming complex whose marked characteristics is the reproduction of almost all crops by seed (mainly cereals, pulses and oil crops), whereas tuber crops are negligible (Westphal, 1975). A survey conducted by MOA (1984) showed that annual crops accounted for 89.3%, perennial crops 0.6%, irrigated crops 0.2% and fallow land 10.1% of the total agricultural land of the region. Annual crop production under rainfed cultivation is, therefore, the predominant occupation of the rural population. Permanent tree crops like coffee, are not common in the region.

Dodota- Sire, Limu- Blbilo, Gedeb, Hetosa, Digelu-Tijo, Tiyo and Munessa weredas (in the former Chilalo awraja) are well known especially for wheat production. These are weredas which are highly influenced by CADU/ARDU and state farm activities. Kofele wereda, which is the most populous one is well known for its enset and livestock production.

In the region, mixed farming is common (90.8%), while crop production alone and livestock production alone account for 6.89% and 2.31 percent of the total farming system respectively (CSA, 1995). Live stock is used for draught animal, a source of additional income and home consumption. Almost every peasant farmer in Arssi employ oxen for ploughing which implies that livestock in the region has a significant impact on crop production.

The different farming practices are governed by the climatic conditions, the nature of the soil and other factors like the density of population, and the tribal customs. Irrigation is not commonly used; only the most extensive plantations are equipped with sufficient irrigation system.

In the lowland areas where the plots are very small hoe culture is used. The farm is worked in narrow strips by spading it with hoe.

Semi-mechanized farming which was run privately before the Rural Land Proclamation of 1975 was practised mainly in Chilalo awraja. Nevertheless, this group constituted only a very small percentage of the total number of farmers.

As far as fertilizer consumption is concerned, Arssi stands second to Shoa. Arssi accounts for 20% of the total fertilizer consumption of the country (MOA, 1988). Time after time, the region is becoming the major contributor to the national cereal market supply (Amare, 1995).

4.1 The Integrated Rural Development Project in Arssi

The rural development project in Ethiopia called CADU, latter renamed as ARDU and SEAD is one of the oldest and best known projects assisted by SIDA.

Arssi is one of the few surplus cereal producing regions in the country. It has successfully implemented the most important integrated rural development programs in Ethiopia (CADU and ARDU) in 1967 and 1974 respectively. These projects have made important economic and social impact.

On the eve of the 1974 revolution, commercial and mechanized farming began flourishing in Arssi. CADU'S support in the form of improved seeds, fertilizers, and technical advance enhanced the expansion of mechanized farming. The development of mechanized farming and the increasing effect of these integrated rural development projects changed Arssi from a subsistence region in the 1960's to the third largest regional contributor to the national commercial cereal market next to shewa and Gojjam (Almaz, 1990). Such development also brought along with it large migration into the region on one hand and the incidence of eviction of poor peasants caused by the capital intensive nature of the technology employed.

CADU combined the functions of many ministries in one unit. The program primarily include adaptive research on crop and livestock production, input supply and dissemination of proven technologies, credit and marketing services, soil and water conservation, forestry, and building of health services (Alemneh, 1987). Among its major objectives were balanced economic and social development among small farmers through increased productivity and income, and dissemination of new extension technology for latter application in other regions of the country (Seleshi, 1982).

It was in its third phase (1976 to 1986) of operation that CADU expanded its program to Ticho and Arbagugu awrajas in addition to Chilalo. It was renamed ARDU and included the entire Arssi region. Even though ARDU still employed the "package approach" of CADU (i.e input distribution and extension) to increase peasant farmers' production, it also emphasized the establishment of co-operative societies to bring about a socialist transformation of the peasant sector (Alemneh, 1987).

4.2. Land-use Pattern for Private Peasant Holdings in Arssi

According to the 1994/95 Agricultural Sampling Survey (Report on Land Utilization), the predominant proportion of peasant land holdings is under temporary crops in the region, i.e. 66.9% of total peasant land holdings, followed by grazing land and fallow land with 19.6% and 7.8% of all land uses respectively (see table 4.1). Wood land occupies a very small percentage (0.38%) of all total land use. This shows that extensive deforestation has been taken place in the area.

Table 4.1 Estimate and Percentage of Area Under Different Land Use for Private Peasant Holdings, 1994/95

Type of Land use	Total Area ('000 ha).	Percentage
Temporary Crops	525.96	66.90
Permanent Crops	8.05	1.02
Grazing Land	154.24	19.61
Fallow Land	61.46	7.82
Wood Land	3.02	0.38
Other Land use	33.6	4.30
All Land Use	786.35	100

Source: Computed from CSA Report on Land Utilization (Private Holdings) Vol. IV, Statistical Bulletin 132, Addis Ababa, October,1995

Land holding system has impact on agricultural production especially in investment of big capitals and the application of modern factor inputs. In high-land and plateau areas of Arssi where population density is very high, farm land owned by individual peasant farmers is very fragmented. Mulate (1989) reported that an increasing population pressure in the highlands has reduced the size of individual holdings to less than 1.5 ha in 9(out of 14) provinces of the country.

The land use pattern at wereda level shows that Lemu-Bilbilo (76,847 ha) followed by Dodota-Sire (69,200 ha) and Robe (62,711 ha) has the highest arable land as compared with Aseko which has the least area of arable land with value of 20,639 ha. As far as forest land is concerned, seru (75,747 ha) followed by Munessa (49,094 ha) and Gololcha (47,949 ha) is the leading one while Gadeb (399 ha) is the least of all weredas of the region. Grazing land is higher for Seru (49, 718 ha), Gololcha (38,499 ha) and Gadeb (37, 610 ha) weredas as compared to Tena being the least one with value of only 5998ha. (see Appendix- 2).

4.3 Size of Cultivated Land

The peasant farming sector is the most important sector in Ethiopia's economy. Small holder peasants are organized as members of peasant associations. They account For 90% of the agricultural labour force and cultivated 94% of the cropland (Alemneh, 1987).

Some studies on average crop area per house hold (ha) by type of crop indicate that Arssi was estimated to have 1.51 and 0.03 for temporary and permanent crops respectively for the year 1991/92. In the same year the regional (Arssi) total average crop area per house hold was 1.4 hectare. The values for 1994/95 were 1.03 and 0.20 hectares for temporary and permanent crops respectively, which shows some sort of decline in particular to the first type of crop (temporary crop) as compared with that of 1991/92 while there is a slight increase in the second one (CSA 1995/1995).

In general, the findings from Arssi suggests that land holding per capita of peasant farmers is probably to decrease under the present conditions. Miniplots of under 1 hectare are not favourable to the use of improved agricultural inputs. Consequently, diminutive land holdings per capita poses serious hindrances to improvement in agricultural production as well as to the ecology of the area.

4.4 Change in Cultivated Land (1986-1997)

Table 4.2 summarizes the pattern of change of cultivated land in Arssi region at wereda level. The table clearly shows that there has been significant difference in the magnitude of change among the weredas of the region. Although most of the weredas showed increment in the size of cultivated land between 1986-1997, three of them (Ziwai-Dugda, Tiyo and Shirka) Showed percentage decline of -7.48, -19.88 and -13 with values of -0.68, -1.81 and -1.18% change/annum during the period 1986-1997.

Table 4.2: Change in cultivated Land (ha) in Arssi Region, by wereda, 1986-1997

Wereda	1986[1]	1997[2]	% Change	% Change/annum
Robe	16573.25	35758	115.76	10.52
Ziwai-Dugda	34072.2	31528	-7.48	-0.68
Tena	25707.5	27965	8.78	0.80
Seru	15355	31808	107.15	9.74
Amigna	11128.4	19209	72.61	6.60
Munessa	18370	37497	104.12	9.47
Tiyo	24799.75	19870	-19.88	-1.81
Dodota-Sire	48393.23	49200	1.67	0.15
Hitosa	31696	49420	55.92	5.08
Jeju	17719	38851	119.26	10.84
Gololaha	18003.69	34036	89.05	8.10
Kofele	24518.5	35469	44.77	4.07
Shirka	33651	29278	-13	-1.18
Gadeb	12772.6	59549	366.22	33.29
Lemu-Bilbilo	30884	45425	47.08	4.28
Digelu-Tijo	23260.6	38758	66.63	6.06
Sude	25369.6	35740	40.88	3.72
Cholle	8033	27018	236.34	21.49
Aseko	13775	19645	42.61	3.87
Merti	27901	39885	42.95	3.90
Total	443974.63	671873	51.33	4.67

Source: Compiled from

1. MOA: South-Eastern Agricultural Development (SEAD) Zone Annual Report: 1986; Planning and Programming service: SEAD Publication No 1. Assela, 1986.
2. Arssi Zone Agricultural development Office: Planning and Programming Section, Assela.

NB: Due to boundary reclassification of woredas Guna is included in Merti.

On the contrary, Gadeb (366.22%) followed by Cholle (247.33%) attained very substantial increment with value of 33.29 and 22.48% change/annum. In general, the region showed about 51.33 percent change of increment in the size of cultivated land during the same period which is a percentage change of 4.67 per annum.

4.5 Crop Production

Crop production is affected by the physical environment of a region especially by its climate, soil and topography.

In the region, there are two cropping seasons, the belg or small (spring) rains and the meher or the big summer (Kiremet) rains. According to the CSA estimate, for the year 1994/95, the production of the region was 7880310 quintals of which cereals contributed about 88.97%, pulses 7.87% and, oil seeds 3.73% respectively (see Table 4.4). Of the total production of major cereal crops during the same year, 93.32% was produced during Meher season as compared with 6.68% during Belg (See Table 4.3).*

---

* Note that there is slight difference between table 4.3 and 4.4 interms production figure. The reason could be due to the use of different sources to complete table 4.3

Table 4.3 : Production of Selected Major Cereal crops for private Holdings in 1994/95 by season.

Thousand Quintals

Crop Types	Meher Season		Belg Season		Total	%
	Production	%	Production	%		
Teff	488.88	7.6	2.98	0.6	491.86	7.1
Barley	1904.53	29.4	315.06	68.1	2219.59	32.0
Wheat	2165.93	33.5	32.76	7.1	2198.69	31.7
Maize	1704.91	26.4	112.08	24.2	1817.82	26.2
Sorghum	204.40	3.2	-	-	204.40	2.9
Total	6468.65	100	462.88	100	6931.53	100

Source: CSA, Agricultural Samples Survey, Report on Area and Production for Major crops (Private Holdings) 1994/95. For Meher season, statistical Bulletin No.132, pp.30 and for Belg, Statistical Bulletin No. 141 pp.58

As it can be seen from the table, of all the major cereal crops, wheat, barley and maize account for the largest production. The pattern of production shows that during the Meher season, the volume of production of wheat was the leading one followed by barley and maize. On the other hand, during the Belg season, barley stands first followed by maize in volume of production.

4.5.1 Cropped Area, Production and Yield

As far as area and production is concerned, cereals were the predominant crops. Out of the total land holding under crops about 82.83% (476410 ha) was covered with cereals. Among the cereals, however, barley and wheat were the most significant in that they accounted for 32.92% and 32.30% of the area under cereals and 29.11% and 30.92% of the total cereal production respectively (see table 4.4).

The next crops in terms of significance were pulses followed by oil seeds. pulses accounted for about 8.80% of the total major crops area and 7.87% of the annual major crop production. The area under oil seeds contributed about 8.37% of the total area with only 3.73% of the total major crops out put.

As far as yield of major crops grown in the region is concerned, cereals (14.72 qt/ha) accounted for the highest yield followed by pulses (12.25 qt/ha) while oil seeds with 6.11 qt/ha were the least productive. This is much more greater than the national average yield figures of cereals (10.22 qt/ha), pulses (8.61 qt/ha) and oils seed (3.43 qt/ha) for the same year (CSA, 1994/95 raw data). However, there is significant variation in terms of yield even among the same type of crops. For instance, maize, sorghum and wheat had 21.55, 14.76 and 14.09 qt/ha of yield respectively as compared with teff (7.59 qt/ha). Surprisingly, yield of maize was much more greater than that of teff in this crop year. In addition to the cropping pattern of the region as a whole, it is also important to examine it at wereda level.

Appendix-3 summarizes the patterns of total land cultivated, production and yield of major crops (cereals, pulses and oil seeds) by wereda in 1996/97. Total production is estimated at 5827906 quintals. Cereals are the leading crops in terms of area and production. Out of the total land holding under crops about 85.3% (536656 ha) is covered with cereals Lemu-Bilbilo 42,836 ha, Dodota - Sire 42,462 ha and Hetosa 42,395 ha have the highest area under cereal crops. However, Degelu-Tijo 12.1% (674362 qt), Gedeb 13.7% (763816 qt) and

Munessa 8.7% (486954 qt) are more important in terms of cereals production (contributing about 34.5% of the total annual cereals production together).

Pulses are more important in Cholle (35855 qt) and Hetosa (21963 qt) than any other woredas of the region. They account for 18.3% and 11.2% of the total annual production of pulses in the region. Oil seeds are the least important in terms of cultivated area, production and yield. They are produced relatively in more quantity in Digelu-Tijo and Limu Bilbilo (see Appendix- 3).

Table 4.4: Area, Production and Yield of Major Crops (for Both Seasons) for Private Peasant Holdings, 1994/95

Crop Type	Total Area (000 Ha)		Production (000'QT)		Yield (Qt/ Ha)
	Number	%	Number	%	
Cereals	476.41	82.83	7011.16	88.97	14.72
Teff	64.43	11.20	488.88	6.20	7.59
Barley	156.83	27.27	2040.65	25.90	13.01
Wheat	153.89	26.76	2167.61	27.51	14.09
Maize	80.22	13.95	1728.88	21.94	21.55
Sorghum	13.85	2.4	204.40	2.59	14.76
Millet	-	-	-	-	-
Oats	7.19	1.25	79.63	1.01	11.08
Pulses	50.59	8.80	619.94	7.87	12.25
Oil seeds	48.14	8.37	294.21	3.73	6.11
All crops	575.14	100	7880.31	100	13.70

Source: Compiled from CSA, Agricultural Samples Survey Report on Area and production for Major crops (Private Holdings), 1994/95.

Regarding yield of cereals, Digelu-Tijo (20.2 qt/ha) & Gedeb (19.49 qt/ha) are prominent while Ziwai-Dugda (3.2) being the least important. Pulses have higher yields in Munessa (6.1qt/ha) and Cholle (5.7 qt/ha) and oil seeds are relatively more productive in Degelu-Tijo (3.6), Tiyo and Dedota-Sire (3.2) qt/ha each. The fact that we find yields being higher in some weredas and lower in others might have been due to variation in agro-ecological zones, magnitude of fertilizer and improved seeds application, mechanization etc.

4.5.2 Crop Production Over Time

Table 4.5 shows that there has been substantial increment in the amount of crop produced between 1979/80-1994/95 in Arssi region by about 89.9% or on average by 6% per annum. The largest increment in production was shown in oilseeds (14.4% perannum) and the least in pulses (o.6% per annum). In sum, the region experienced a substantial growth in major crop production with a value of 6% per annum.

Table 4.5 Change in Production of Major Crops For Private Holdings (For Both Seasons) (1979/80-1994/95)

Thousand Quintals

Crop	1979/80	1994/95	% Change	% Change/annum
Cereals	3500	7011.16	100.3	6.7
Pulses	568.58	619.94	9.0	0.6
Oil seeds	81.49	294.21	216.0	14.4
Total	4150.07	7880.31	89.9	6.0

Source: CSA Time Series Data on Production of Major Crops.

More over, Appendix-4 shows change in the production of cereals over time (1982/83-1996/97) by wereda . As it is clearly shown, production of cereals declined (in 10 of the 20 districts). Among the districts which gained substantial increase in production, Gedeb (339.9%) followed by Digelu-Tijo (175.9%) and Lemu-Bilbilo (123.6%) with values of 24.28, 12.6 and 8.83% change per annum respectively are the leading ones. This might have been because of production increasing activities (fertilizer and improved seeds application, mechanization etc.) of ARDU in these weredas of the former Chilalo awraja. On the other hand, the highest level of percentage decline is observed in

Merti (-66.6) which is a percentage change of -4.76 per annum. This is so because the 1982/83 production figure of Guna is included in that of Merti in the same year (for the sake of comparability). Most part of the previous Guna wereda is now included in Merti even though the remaining part went to Aseko and Cholle weredas according to the recent reclassification of boundaries of the weredas of the region. This situation resulted in down-ward shift (loss) for Merti and upward shift(gain) for Aseko and Cholle in volume of production for 1996/97 as compared with that of 1982/83. However, the regional cereal production increased by about 20.4% (1.46% per annum).

4.5.3 Yield Variation Over Time

According to CSA, Time Series Data on yield of major cereals (1979/80-1989/90) and data from Arssi Zone Agricultural Development Office (1990/91-1995/96), there has been significant variation of yields from crop to crop. They were less variable for barley, teff and wheat (CV=14% -21%) but more variable for maize, sorghum and Oats (CV=31%-36%) (See Table 4.6).

For the regional analysis of yield of major cereal crops, average yield and % change by type of crop are used. Table 4.7 shows the spatial and temporal variation in average yield with in the region by wereda. In general, yield of cereals declined from 17.4 qt/ha in 1994/95 to 9.8 qt/ha in 1996/97 with a percentage change of -43.7 (-21.85% perannum) in the region as a whole.

Although it showed a declining trend over time, wheat followed by barley had the highest yield with values of 17.6 qt/ha and 15.6 qt/ha respectively for the year 1994/95 in Arssi region. Surprisingly, it is only barley which showed a percentage decline (only by about -21.9 (-10.9 per annum)) among all the major cereal crops between 1994/95-96/97. However, percentage change (increase) of barley is observed in Cholle (75.4) Hitosa (64.8) and Digelu-Tijo (11.1) while Mrti (-55.8) had substantially the lowest figure (decrease).

Table 4.6 Yield of Major Cereals in Arssi (1979/80-1995/96)

Crops	Teff	Barley	Wheat	Maize	Sorghum	Oats
Average Yield	55.67	100.82	67.17	409.95	571.79	163.26
X	8.71	13.55	14.05	15.71	16.26	9.24
S.D.	1.81	2.44	1.99	4.91	5.80	3.19
C.V.(%)	20.78	18.01	14.16	31.25	35.67	34.52

Source: Computed by the author from CSA Time Series Data, 1979/80-1989/90 and Data from Arssi Zone Agricultural Development Office (1990/91-1995/96), Reports on Area Under Major Crops, Production and Yields of Major Crops.

Where: X = Mean
S.D = Standard Deviation
C.V = Coefficient of Variation Calculated as
C.V = S.D/X x 100
Average Yield = Yield (Qt/Ha) of Major Cereals for the years 1979/80-1995/96.

All the districts showed fall in yield of teff between the years. Weredas which didn't show percentage decline of yield of wheat are Gedeb, Koffele and Digelu-Tijo. For maize, almost all weredas showed significant decline over time with the exception of Munessa. Surprisingly, most of the weredas showed percentage decline over the years. As far as yield of sorghum is concerned three weredas namely Robe (8.3%) Amigna (50%) and Munessa (63.6%) showed percentage increase (see Table 4.7).

In general, the declining trend of yields of these cereal crops might have been due to limited crop rotation (for example, cultivating cereals after cereals) which leads to the overuse of certain nutrients of the soil, declining per capita farm size stimulated by increasing population pressure (which causes over cultivation) and insufficient use of fertilizers and improved seeds (not enough to reverse the declining trend). In addition, weeds infestation, insect problems, wild animals and the like could be the possible reasons.

Table 4.7: Change in Average Yield of Major Cereal Crops by Wereda for Main Season (1994/95-1996/97). (Qt/Ha).*

Wereda	Teff			Barley			Wheat		
	1994/95	1996/97	% Change	1994/95	1996/97	% Change	1994/95	1996/97	% Change
Merti	6	2	-66.7	11.3	5	-55.8	11.2	4	-64.3
Jeju	12	3	-75	15	7	-53.3	18	6	-66.7
Aseko	6.9	1	-85.5	12.2	8.75	-28.7	12	6.15	-48.8
Cholle	11.6	3	-74.1	17.1	30	75.4	19	13	-31.6
Gollelcha	6	2	-75	10	6	-40	11	7	-36.4
Tenna	10.4	3	-71.2	14.8	10	-32.4	16	8	-50
Sude	10	2	-80	13	7	-46.2	15	5	-66.7
Seru	8.7	1	-88.5	15.7	8	-49	18.6	9	-51.6
Robe	10	3	-70	12	12	0	15	13	-13.3
Amigna	12	2	-83.3	15	8	-46.7	19	10	-47.4
Ziwai-Dugda	3	0.10	-96.7	5	3	-40	6	4	-33.3
Hetosa	10.6	5	-89.3	9.1	15	64.8	22	21	-4.5
Munessa	10	4	-60	16	13	-18.8	18	15	-16.7
Dodota-Sire	6.9	4	-42	10.9	7	-35.8	13.6	7	-48.5
Gedeb	8	4	-50	18	11	-38.9	22	22	0
Koffele	-	-	-	15	12	-20	12	12	0
Lemu-Bilbilo	9	4	-55.6	18	12	-33.3	20	10	-50
Shirka	12	3	-75	15	9	-40	18	8	-55.6
Digelu-Tijo	8	6	-25	18	20	11.1	20	20	0
Tiyo	10	4	-60	16	15	-6.3	20	13	-35
	9.6	2.8	-70.5	15.6	12.19	-21.9	17.6	12.3	-30.1

Table 4.7 Cont'd

Wereda	Maize			Sorghum			Cereals Total		
	1994/95	1996/97	% Change	1994/95	1996/97	% Change	1994/95	1996/97	% Change
Merti	13.2	9	-31.8	10.4	6	-42.3	10.8	4.7	-34
Jeju	20	4	-80	13	10	-23.1	15.7	5.6	-64.3
Aseko	19.7	3.5	-82.2	17.8	3.17	-82.2	15.6	5.5	-64.7
Cholle	19.3	9	-53.4	11.8	10	-15.3	17.1	14.2	-17
Gollelcha	20	8	-60	12	7	-41.7	30.5	5.7	-81.3
Tenna	24.6	6	-75.6	18	7	-61.1	15.9	8.5	-46.5
Sude	15	10	-33.3	12	-	-	13.4	4.3	-67.9
Seru	20	6	-70	15	8	-46.7	16.8	7.5	-55.4
Robe	18	17	-5.6	12	13	8.3	13.6	10.5	-22.8
Amigna	20	7	-65	16	8	50	18.6	8.2	-55.9
Ziwai-Dugda	10	4	-60	8	0.15	-98.1	8	3.2	-60
Hetosa	15	6	-60	12	10	-16.7	13.2	5.2	-60.6
Munessa	20	20	0	11	18	63.6	16.9	14.3	-15.4
Dodota-Sire	7.8	1	-87.2	9.5	1	-89.1	10.5	5.9	-43.8
Gedeb	-	10	-	-	-	-	20.5	19.5	-4.9
Koffele	15	6	-60	-	-	-	14.2	11.9	-16.2
Lemu-Bilbilo	12	9	-25	-	6	-	18.5	10.8	-41.6
Shirka	12	4	-66.7	10	3	-70	15.0	6.5	-56.7
Digelu-Tijo	12	20	-65	-	-	-	18.6	20.7	11.3
Tiyo	20	7	-53.4	12	10	-16.7	17.2	12.6	-26.7
Total	15.1	7.03	-53.4	12.6	7.61	-39.6	17.4	9.8	-43.7

Source: Arsi Zone Agricultural Development Office, Assela

* The data show yield only for two years time interval. The data is chosen because it is data from the same source and was found to be better in its quality than other data available for time series.

4.6. Methods of Agricultural Intensification

4.6.1 Application of Chemical Fertilizer and Improved Seeds

Due to various agricultural institutions and extension services, the application of modern factor inputs has been widely - practised in Arssi. However, its magnitude differs from farmers to farmers and from place to place.

4.6.1.1 Proportion of Farmers using Fertilizer

According to the 1983/84 MOA General Agricultural survey, the proportion of chemical fertilizer users were higher for three regions of the country. These regions were Arssi (47%),Shewa (24%) and Gojjam (16%). These are the regions in which large percentage share of fertilizer consumption is concentrated (MOA, 1984)

Proportion of fertilizer users are not uniform in Arssi region and therefore there is variation among awrajas and with in awrajas i.e at wereda level. In this case, the former Chilalo Awraja, where fertilizer demonstration was undertaken earlier before other awrajas of the region, is by far the major fertilizer consumer and has a large proportion of users. For example, according to Appendix -5, in Chilalo, the proportion of farmers using fertilizer was 56% followed by Ticho awraja.

As the Appendix unfolds, Chilalo had the largest proportion of users. Regarding woredas, Hetosa followed by Amigna and Tiyo had the leading proportion of users. In these woredas, the proportion of users are about 91%, 81% and 80% respectively. On the other hand, the lowest proportion of users were observed in Ziway-Dugda wereda which was 2% (see Appendix - 5). This is so because the arid climatic condition of the wereda is not conductive for crop production.

In addition to the proportion of users, the per capita fertilizer consumption was greater in Arssi according to the 1983/84 General Agricultural survey. The per capita consumption is about 31.75 kgs per capita while the other giant fertilizer consumers, shewa and Gojjam followed. On the average, a farmer in those regions applied about 18.95 kgs and 9.06 kgs of fertilizer (MOA, 1984). This also implies that, several of the farmers of Arssi recognized the economic benefit of fertilizer better than other regions of the country.

The per capita fertilizer consumption in the region varies from one wereda to the other. It varies from 73.68 kg per capita in Digelu to 0.98 kgs in Ziwai-Dugda. In short, the pattern of per capita consumption clearly shows that woredas of the former Chilalo awraja had greater per capita consumption of fertilizer than other woredas of the region (see Appendix -5).

4.6.1.2 Fertilizer Consumption over Time (1988-97)

Table 4.8 presents the spatial distribution of fertilizer consumption in the 20 - weredas of the region over time (1988-1997). The table shows that there has been important increment in fertilizer consumption, which is more than half (52.36) percentage change or on average 5.82% per annum for the region as a whole. The level of fertilizer consumption shows significant spatial disparity among the districts. For instance,-Lemu-Bilbilo followed by Tenna and Hitosa showed the largest percentage increment (15.17% per annum). On the contrary, Amigna and Kofele showed substantial decline with values of -4.77 and -2.22% per annum (see Table 4.8).

Table 4.8 Change in Consumption of Fertilizer for Arssi Region by Wereda-(1988-1997).

Wereda	Fertilizer (DAP and Urea) (qts)		% Change	% Change/annum
	1988[1]	1997[2]		
Tiyo	10,055	14,234	41.56	4.62
Hetosa	13,499	30,803.5	128.19	14.24
Dodota-sire	11,568.9	15,257	31.88	3.54
Zwai-Dugda	646	988.1	52.96	5.88
Digelu-Tijo	11,568.9	25,507.5	113.61	12.62
Munessa	10,055	22,351	122.29	13.59
Lemu-Bilbilo	11,390.5	26,941.5	136.53	15.17
Shirka	9,350.5	9472	1.30	0.14
Gedeb	10,968.5	10621.5	-3.16	-0.35
Kofele	7,228.5	5786	-19.96	-2.22
Sude	5,329.5	6090	14.27	1.59
Robe	4,853	8751	80.32	8.92
Tenna	4,254.5	10023.1	135.59	15.07
Amigna	6,535.5	3727	-42.97	-4.77
Seru	7,904.5	10509	32.95	3.66
Jeju	8,149	8524.5	4.61	0.51
Merti	5,741.5	4696.5	-18.20	-2.02
Chole	2,269.5	3104	36.77	4.09
Aseko	880	142.5	83.81	9.31
Gololcha	-	3.5	-	-
Total	142,779.4	217,533.2	52.36	5.82

Source 1. AISCO, South-eastern Branch Co-ordination Office, Assela

2. Ethio-Italy Rural Development Project: Mission for the Assessment of the Extension System in Arssi and Bale Zones, Assela

4.6.1.3 Improved Seeds

Farmers in the region are not only users of fertilizers but also of improved seeds. This shows that there is better access for extension services than other regions of Ethiopia.

In Appendix-5, it is shown that about 21% of farmers in the region used improved seeds. The data also shows that there was significant variation among weredas in the same year. For instance, Digela (68%) followed by Lemu (58%) and Guna (54%) had the highest proportion of farmers using improved seeds as compared with the least users in Ziwai-Dugda and Tenna with a proportion value of 4%.

Appendix-6 shows that there is variation among woredas in terms of improved seeds sales by type of crop. Wheat followed by barley and maize is the leading seed in the region. Here, Hitosa (3954.5 qts) followed by Dodota - sire (1331.3 qts) and Gedeb (1248.8 qts) is the prominent consumer of improved seed of wheat (these weredas are also higher users of fertilizer) while Sude is the lowest with value of 3.0 qts. Barley is very important in Digelu-Tijo (970 qts) followed by Lemu-Bilbilo while it is totally absent in Zwai-Dugda, Sude, Amigna, Merti, Aseko and Gololcha. Maize, the lowest seed interms of improved seed consumption, is relatively abundant in Zwai-Dugda (54.5 qts) and Gololcha (38.4 qts) while it is not used in Degelu- Tijo, Lemu-bilbulo, Gedeb and Kofele as an improved seed (see Appendix -6).

4.6.2 Irrigation Activities

4.6.2.1.Spatial Pattern of Irrigated Land

The spatial pattern of Irrigated area is shown in Appendix-7. It is only 0.3% of the total cultivated land that is irrigated. This is a percentage increase of 50% as compared with the share of irrigated crops (0.2%), according to the survey made by MOA (1984). As it is shown, there was substantial spatial disparities among the werdas of the region regarding the percentage share of irrigated land (see Appendix -7).

For instance, Aseko (105 ha) followed by Tiyo (179.75 ha) had the highest percentage share of irrigated land with values of 0.76 and 0.72%. On the other hand, Robe (0.0075%) followed by Dodota (0.0669%) had the lowest percentage share. Weredas which had no any irrigated land are Amigna, Munessa, Hitosa, Jeju, Gololcha, Kofele, Gedeb, Digelu-Tijo and Sude (9 of the 22 districts).

4.6.2.2 The Present Pattern of Water Resource Potential

Although detailed studies have not yet been conducted so far on the level of rivers economic potential and Utilization, rough approximation shows that 21410.15 hectares of land could be irrigable using surface water resources. Out of this, only 8507 hect. or 39.7% is irrigated in modern small scale irrigation scheme by both peasants and state farms (see Table 4.9). There are traditional irrigations practised on 4238.2 ha of land by diverting streams and developing springs by peasant farmers (see Table 4.9).

Table 4.9: Water Resource Potential and the Degree of Utilization in Arssi, 1997

Irrigation Activities	Unit (hec.)	Percent
1. Potentially irrigable land of the zone	21410.15	100
2. Irrigated (actually)	12745.2	59.53
2.1 Traditional small scale irrigation	4238.2	19.80
2.2 Modern Small scale irrigation	1933	9.03
2.3 State farms	6574	30.70
3. Irrigable area in the future (by rivers)	8664.95	40.47

Source: Office of Water, Energy and Mineral Development for Arssi Zone, 1977 (cited in Tesemma, 1997 (Assela).

In sum, the region has experienced significant agricultural development (change) in terms of cultivated area and production of major crops (cereals, pulses and oils seeds) through time. However, there has been significant spatial disparity in the level of agricultural development (change) when we examine the situation at wereda level.

Unlike the increase in cultivated area and production of the major crops, yield has shown significant declining trend both at the region and wereda level in general. This might have been due to multitude of factors such as physical (soil degradation, ran fall variability etc.), overgrazing, over cultivation, limited crop rotation, weed infestation, insect problems and the like. In the next chapter, we shall see the nature and level of population size and change in the region as indicated by rural population density and migration.

CHATER FIVE

V. Population Size, Growth and Distribution

5.1 Size and Growth

The population of Arssi was estimated at about 872,700 in 1973. At that time, the population density was 37 persons per square kilometer, which was of course greater than the national average (22.8 persons per square kilometer) (CSO, 1975). The 1984 population and housing census showed that Arssi's population was 1,662,790 with an increase of 90.5% as compared with that of the 1973 estimate. Population density also increased to the level of 70.2 persons per square kilometer. Only 8% of the region's population lived in urban areas (CSA, 1984).

According to OPEDB (1997), the total population of Arssi was 2,327,043. Of the total population of the region, only 234,954 (10.1%) lived in urban centers. The remaining 2,092,089 or 89.9 percent lived in rural areas. Between 1984-1996, population increased by 39.95% (from 1,662,790 to 2,327,043) or 3.33% per annum on average in the study area. This increase is estimated at an average annual growth rate of 2.8% (see table 5.1). However, population growth in the region showed significant spatial disparity.

Population growth in the region varies from one agro-ecological zone* to the other. Generally it is higher mainly for Dega and Woina Dega areas but lower for kolla areas. (See table 3.4 and table 5.1).

---

* Note that a wereda is classified as one of the three agro-ecological zones which has the highest percentage share for the wereda

Table 5.1 Growth of population in the study Region by Wereda, 1984-96

Wereda	1984	1994	1996	% Change (1984-96)	% Change/ year(1984-96)	Ave. Grwoth rate/anuum (1984-96)
Merti	94,074	93,895	98,761	4.98	0.42	0.41%
Aseko	42,508	61,513	64,363	51.41	4.28	3.46%
Gololcha	90,642	117,828	123,300	36.03	3.00	2.56%
Jeju	76,208	88,832	93,094	22.16	1.85	1.67%
Dedota-sire	130,674	107,846	113,541	-13.11	-1.09	-1.17%
Ziwai-Dugda	64,271	86,691	90,742	41.19	3.43	2.9%
Hitosa	91,286	174,360	183,161	100.65	8.39	5.80%
Sude	93,910	113,652	118,895	26.61	2.22	1.97%
Cholle	48,398	80,131	83,955	73.47	6.12	4.59%
Amigna	46,484	54,280	56,900	22.41	1.87	1.68%
Seru	52,666	80,358	84,197	89.87	7.49	3.91%
Robe	80,980	118,457	124,374	53.59	4.47	3.58%
Tena	72,843	91,418	95,937	31.70	2.64	2.29%
Shirka	116,822	112,743	118,151	1.14	0.09	0.094%
Digelu-Tijo	76,321	104,136	109,192	43.07	3.59	2.98%
Tiyo	90,337	117,197	124,601	37.93	3.16	2.68%
Munessa	107,168	148,030	155,172	44.79	3.73	3.08%
Limu-Bilbilo	90,673	165,788	174,026	91.93	7.66	5.43%
Gedeb	79,197	120,382	126,309	59.49	4.96	3.89%
Koffele	117,328	179,708	188,372	60.55	5.05	3.95%
Regional Total	1,662,790	2,327,043	2,327,043	39.95	3.33	2.80%

Sources: 1. CSA: The 1984 Census: Analytical Report on Arssi region: Addis Ababa, 1988

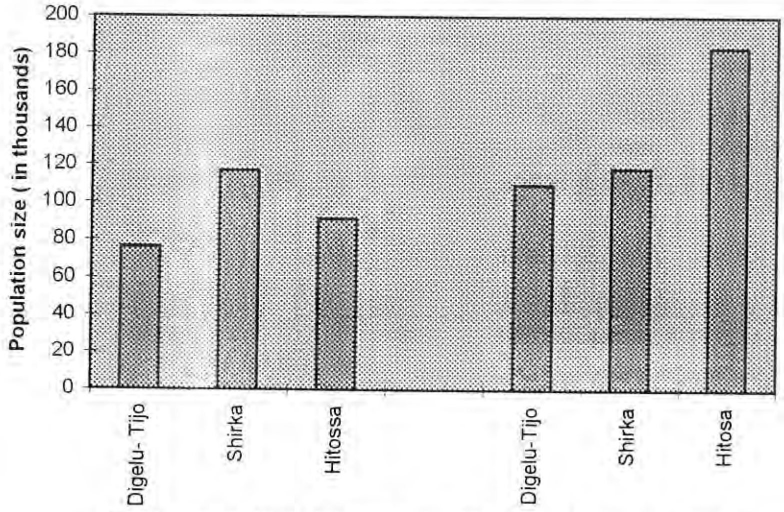
2. CSA. The 1994 Census: Result for Oromiya Region, A.A. 1996

3. Oromiya Planning and Economic Development Bureau (OPEDB) (cited in Regional Atlas of Oromiya, Finfinne, 1997).

N.B. The 1984 population figure of Guna is included in Merti since Most part of it is now reclassified in Merti wereda.

As far as spatial variation among weredas is concerned, the highest rate of population growth was observed in Hitosa (5.80%/annum) while the lowest (decline) was in Dodota -Sire (-1.17% /annum). This decline might have been due to the new reclassification of district boundaries that made the previous two weredas (Dodota and Sire in 1984) one as Dedota - sire with some shift of areal coverage.

Figure 5.1: Population Growth in Some selected Woredas of Arssi Region (1984 and 1996)



The first three bars stand for year 1984 while the second ones for the year 1996 respectively

Figure 5.1 shows population size in some selected weredas for 1984 and 1996. These weredas indicated the highest (Hitosa), moderate (Digelu-Tijo) and lowest, (Shirka) increase in population size. The calculated growth rates are 5.80, 2.98, and 0.094%/ annum for the period 1984-1996.

In general, within the region, a great deal of variation can be observed at wereda level (see table 5.1). For instance, in 1996, the wereda population varies in size from 188,372 in Koffele wereda to 56,900 in Amigna with values of 5.05% and 1.87% change per annum as compared with the population size for 1984 respectively. Variations are also observed in crude population density at wereda level (see table 5.2).

5.2 **Density and Distribution**

According to the 1994 Population and Housing Census (Result for Oromiya Region), Arssi had a total population of 2,217,245 and an average population density of 96.2 p/km2 of land. Out of the total population of the region, 90.24% lives in rural areas while only 9.76% of the population lives in urban areas (CSA, 1994). This clearly shows that the great majority of the population depend on agriculture which is basically affected by environmental factors. In the census, the sex distribution of the population showed that males with 49.86% of the total population are out numbered by the female population with 50.14%.

The highest concentration of population is found in Kofele wereda comprising about 8.11% out of the total population of the region and Amigna wereda accounts for 2.45%, the lowest percentage share of the total population of the region. Population density is highest in Tiyo (180.3P/km2) and lowest in Seru (37.6P/km2) as compared with other weredas of the region for the year 1994 (see table 5.2).

The distribution in Arssi follows certain pattern. Those weredas found in the former Chilalo Awraja have relatively higher density of population than other weredas found in other Awrajas. Out of the 20 weredas of the region, about 13 weredas have population densities greater than the regional average population density. Among these 9 of them are found in Chilalo Awraja (See Figure 5.2).

Several reasons can be mentioned to justify why population is more concentrated in these weredas of Chilalo Awraja than the rest of weredas. One of the reasons could be the fact that agriculture has been improving rapidly due to the introduction of mechanized farming by CADU and ARDU. In addition, the agricultural potential of these weredas together with their proximity to major urban centers (market areas) due to a relatively modern transportation system is higher than other weredas (Belayneh cited in Kebede, 1996). On top of these, good climatic conditions i.e., adequate amount of rainfall and temperature along with a relative absence of tropical diseases such as malaria, have contributed a lot for the prevailing high population concentration in these districts of the region. Such phenomena have resulted in in-migration of many people from other regions (mainly Shewa) in search of job opportunities to these places. In relation to these facts, the booming of towns along the Bale-Asela-Addis Ababa highway, has also contributed to the relatively higher population size and densities of districts of Chilalo awraja (Tessema, 1997). Likewise, there is variation of population density at wereda level among other awrajas (Table5.2).

Table 5.2 Population size, Area and Density by Wereda (1994)

Previous Awraja	Wereda	Area (Km2)*	Population Size	Density (per km2)
Arba-Gugu	Merti	1323	93,895	80.0
	Aseko	626	61,513	98.3
	Gololcha	1708	117,828	69.0
	Jeju	770	88,832	115.4
	Chole	710	80,131	112.9
Chilalo	Dodota-Sire	1010	107,846	106.8
	Ziway-Dugda	1251	86,691	69.3
	Hitosa	1155	174,360	151.0
	Sherka	1083	112,743	104.1
	Digelu-Tijo	842	104,136	123.7
	Tiyo	650	117,197	180.3
	Munessa	1395	148,030	106.1
	Limu-Bilbilo	1516	165,788	109.4
	Gedab	1083	120,382	111.2
	Kofele	1107	179,708	162.3
Ticho	Sude	1323	113,652	85.9
	Seru	2140	80,358	37.6
	Robe	1275	118,457	92.9
	Tena	770	91,418	118.7
	Amigna	1323	54,280	41.0
Arssi		23060	2,217,245	96.2

Source: Computed from CSA: the 1994 population and Housing Census (Result for Oromiya Region), Addis Ababa, 1996 and,

* Regional Atlas of Oromiya (Physical Planning Department) Finfine, 1997.

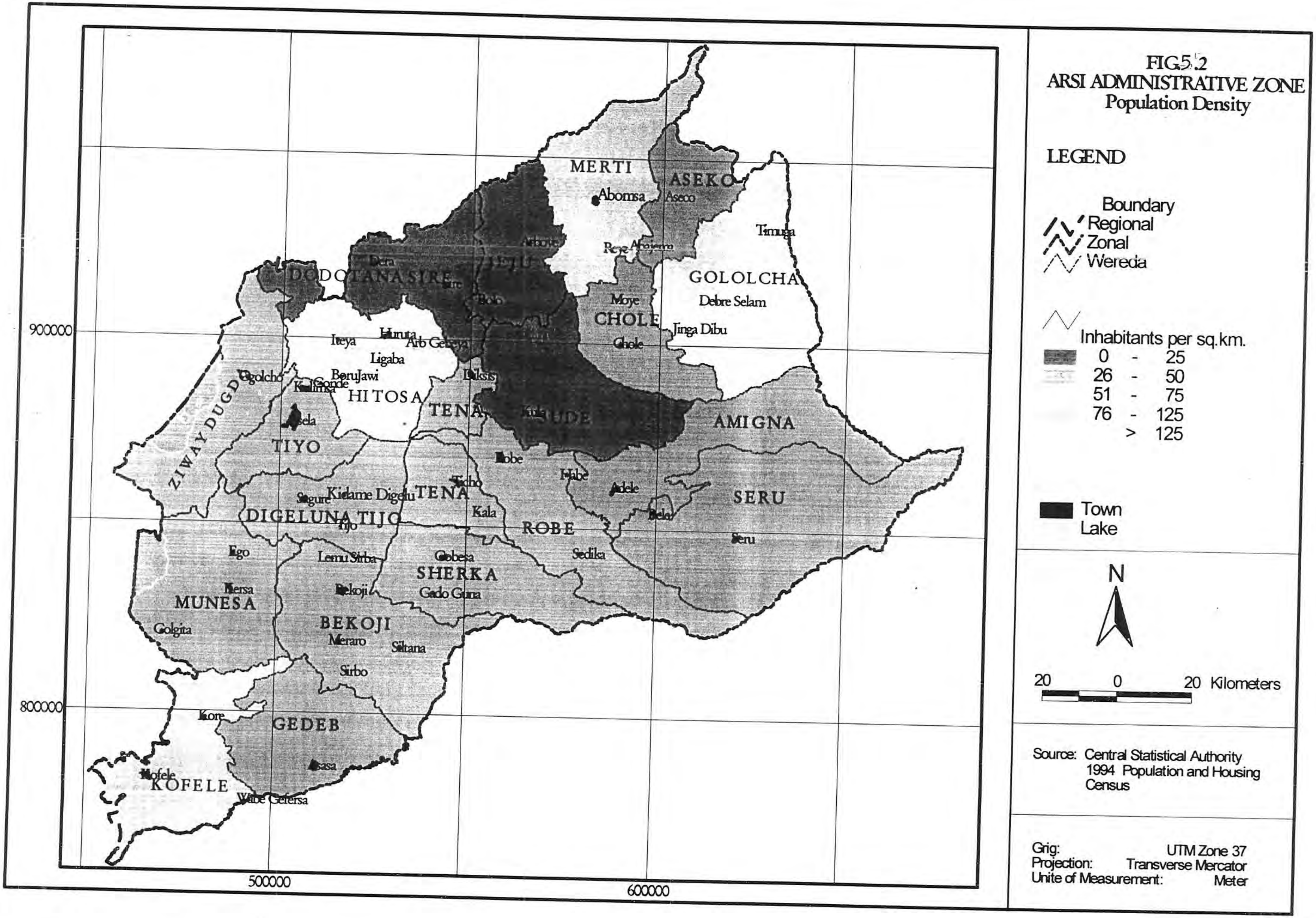


FIG.5.2
ARSI ADMINISTRATIVE ZONE
Population Density
LEGEND
Boundary
Regional
Zonal
Wereda
Inhabitants per sq.km.
0 - 25
26 - 50
51 - 75
76 - 125
> 125
Town
Lake
N
20 0 20 Kilometers
Source: Central Statistical Authority
1994 Population and Housing
Census
Grig: UTM Zone 37
Projection: Transverse Mercator
Unite of Measurement: Meter
900000
800000
500000
600000
MERTI
Abomsa
ASEKO
Aseco
Timuga
GOLOLCHA
Debre Selam
CHOLE
Moye
Chole
Jinga Dibu
DODOTA NA SIRE
Dera
Bolo
Iteya
Huruta
Arb Gebeya
Ligaba
Boru Jawi
HITOSA
TENA
Diksis
AMIGNA
ZIWAY DUGDA
TIYO
Robe
Adele
Bele
SERU
Seru
DIGELUNA TIJO
Kidame Digelu
TENA
Kala
ROBE
Sedika
Lemu Sirba
Gobesa
SHERKA
Gado Guna
MUNESA
Golgita
BEKOJI
Meraro
Siltana
Sirbo
GEDEB
KOFELE
Wabe Gefersa

Uneven distribution of population exerts high influences on the ecology of the environment more than any thing else. Since most of the liveli-hood of the population depends on agriculture, the question of changes in population density is of a great importance, for it implies the concept of man-land ratio. The increase in man-land ratio suggests the increment of population pressure on arable land, which in turn makes the land under forest cover and grazing land to be put under agricultural production and settlement.

5.3 Household Size and Age-Sex Structure

5.3.1 House hold size

According to the 1994 Census, Arssi had average total household size of 5.0. The average household size for rural Arssi was 5.1 while it was 4.3 for the urban areas. For 1984 census it has been reported as 4.8 and 4.4 for rural and urban areas, respectively with the regional average total household size of 4.8 (CSA, 1984, 1994).

Table 5.3 summarizes average farming household size in the region by wereda. The table unfolds that there is significant spatial disparity among the weredas in terms of average farming household size. For example, 7 of the 20 districts have average house hold size greater than the regional average farming household size (7.38). These are Gololcha (9.08), the highest, Limu-Bilbilo (8.61), Jeju (8.42), Munessa (8.40), Kofele (8.10), Amigna (7.78) and Robe (7.51). Tiyo (4.40) has the lowest average farming house hold size.

Table 5.3 Average Farming Household Size in Arssi by Wereda, 1997

Wereda	Total number of farming House holds	Total Rural Population	Average Household Size
Tiyo	14942	65,810	4.40
Hetosa	24888	153,140	6.15
Dodota-Sire	15583	112,716	7.23
Zwai-Dugda	19471	104,151	5.35
Digelu-Tijo	14096	96,265	6.83
Munessa	15870	133,332	8.40
Lemu-Bilbilo	18792	161,773	8.61
Shirka	14990	108,237	7.22
Gedeb	22269	139,192	6.25
Kofele	21083	170,721	8.10
Sude	16165	90,685	5.61
Robe	15116	113,484	7.51
Tenna	12220	86,477	7.08
Amigna	6810	53,000	7.78
Seru	13420	83,606	6.23
Jeju	11560	97,367	8.42
Merti	14179	84,884	5.99
Chole	13204	72,871	5.52
Aseko	9669	66,825	6.91
Gololcha	13061	118,531	9.08
Regional Total	286305	2113067	7.38

Source: Computed by the writer from Data which are obtained from Arssi Zone Agricultural Development Office: Planning and Programming Section.

5.3.2 Age-Sex Structure

The age structure of a population, that is, the proportion of persons in different age groups, is a subject of great significance in demographic analysis. It is determined by the levels of fertility, mortality and migration schedules of the population. Age structure of a population shows the potential of the labour force a country possesses for development activities. It is also a potential source for investigating the dynamics of population growth.

In Arssi region, the sex ratio (male/female ratio) is almost proportional. In the 1994 census, out of the total population of the region, females comprise 50.14% as compared with 49.86% of males. The sex ratio of the region is 99.43, that is, for 100 females, there are 99 males. Nevertheless, this ratio varies from urban to rural areas. At the regional level, for urban centers it is 89.19 while in rural areas it is 100.60 (see Table 5.4). In towns like Assela, the ratio goes to 86.59 (CSA, 1994). The lower sex ratio for urban areas could be because of female dominated migrants into urban areas.

As far as the age-structure of the population of Arssi is concerned (see Table 5.5), young population (0-14) age group accounts for 49.2%, the age group (15-64) comprises 47.57% and those people grouped under old age group

Table 5.4 Sex-structure of the population of Arssi by place of Residence, 1994

Sex	Total	Urban	Rural
Male	1105439	102025	1003414
Female	1111806	114388	997418
Male-Female Ratio	99.43	89.19	100.60

Source:Computed form the 1994 CSA census Report (Result for Oromiya Region), April 1996, Addis Ababa

Table 5.5 Age-Sex structure of Arssi, 1994

Age group	Both sexes(%)	Male(%)	Female (%)
0-14	49.2	24.86	24.32
15-64	47.57	23.1	24.44
64+	3.2	1.8	1.4
Total	100	49.86	50.14

Source: The 1994 Census, Result for Ormiya Region, April, 1996, Addis Ababa

(64 years and above) contribute about 3.2% of the total population. The region is dominated by young population (0-14).

The number of persons who are economically inactive is very high in Arssi. For instance in 1994, the economic dependency ratio of the population was 110.2 (i.e. 100 active persons are supposed to support 110 inactive persons), of which young dependency ratio is 103.4 while old dependency ratio is 6.80 (see Table 5.6). As the table clearly unfolds, the over all dependency ratio of the region (including young and old) showed decline in 1994 as compared with that of the 1991.

The age group (15-64) or the economically productive population of the region accounts for 47.6% of the total population. Concerning sex-distribution in labour force participation, females contribute 24.4% while males account for about 23.1% of the total population of the region (See Table 5.5). However, the level of un employment is relatively higher for females.

5.4 Rural Density

Agricultural density (the number of rural population per hectare of cultivated land), is a good indicator of relative population pressure on land. The result of the computation showen in table 5.7 indicate that the average agricultural density of Arssi declined from 3.5 to 2.99 persons per hectare of cultivated land (a percentage change of -1.12% per annum) between 1984 and 1997. This might be due to the expansion of cultivated land to cope up with the ever increasing population pressure in the region.

Table 5.6: Percentage Distribution of Total Population by Broad Age Groups and Economic Dependency Ratio in Arssi, 1994

Year	Total Population	Age Group						Dependency Ratio		
		0-14	%	15-64	%	64+	%	Young	Old	Over All
1991	2027245	1025539	50.6	873762	43.1	127944	6.3	117.4	14.6	132
1994	2217245	1090511	49.2	1054912	47.57	71822	3.23	103.4	6.8	110.2

Source: Computed from Statistical Bulletin, 1991 and the 1994 CSA census report (Result for Oromiya Region).

There is a significant variation in agricultural density among weredas. For instance, the highest density was in Gedeb wereda with 5.71 persons/hectare and the lowest in Tiyo with 1.91 person/hectare for 1984 while the corresponding figure for 1997 is 4.81 persons/hectare (highest) and 2.13 persons/hectare (lowest) for Koffele and Merti weredas respectively. Some evidence of population growth is mainly observed in Tiyo, Ziwai-Dugda and Limu-Bilbilo weredas which show higher percentage change of population increase between 1984-1997 (see table 5.7). The high population density implies that there is a need for high food production both from crops and animals and also to augment the growth so that people can cope up with the high growth rate of population. The high agricultural density may cause the danger of over use of the districts' soil resources and hence brings land degradation.

5.5 Migration

Migration is one of the population dynamics that determine the trend of population growth and it is difficult to find a reliable data. There is also sever lack of data especially at wereda level. Therefore, it is only the general over view of migration at the regional level, with some data at wereda level discussed here.

Eventhough, the natural rate of increase (births-deaths) has significantly contributed for the rapid population growth in Arssi, the role of migration should not be under estimated. Among the regions for which data are available, Arssi has experienced the highest rate of in-migration next to Bale (Almaz, 1990).

5.5.1 Volume of In-Migration

As its shown in table 5.8, out of the total 1,662,790 people of Arssi, 8.8 percent (145,544) were found to have migrated from other 15 regions of Ethiopia while 9.9 percent (164,699) of them were reported to have migrated from one Awraja to another within Arssi in 1984. The non-migrant population in the region accounted for 91.2% of the total population, only when the 8.8 percent inter regional migrants are considered. This figure, however, needs to be 81 percent if both inter-and intra-regional (8.8+9.9) migrants were considered.

Table 5.7 Percent Change in Average Agricultural Density Between 1984-1997 (by wereda).

Wereda	Average Agricultural Density (Cult-Land/hectare)		%	% Change/
	1984*	1997	Change	annum
Merti	3.10	2.13	-31.3	-2.41
Aseko	3.01	3.40	13.0	1.00
Gololcha	-	3.48	-	-
Jeju	4.10	2.51	-38.8	-2.98
Dodota-Sire	2.30	2.29	-0.4	-0.03
Ziwai-Dugda	1.92	3.30	71.9	5.53
Hitosa	2.73	3.10	13.6	1.05
Sude	3.93	2.54	-35.4	-2.72
Cholle	5.55	2.70	-51.4	-3.95
Amigna	4.20	2.76	-34.3	-2.64
Seru	3.54	2.63	-25.7	-1.98
Robe	4.61	3.17	-31.2	-2.4
Tenna	2.73	3.09	13.2	1.02
Shirka	3.32	3.70	11.4	0.88
Digeu-Tijo	3.03	2.48	-18.2	-1.40
Tiyo	1.91	3.31	73.3	5.64
Munessa	5.66	3.56	-37.1	-2.85
Limu-Bilbilo	2.81	3.56	26.7	2.05
Gedeb	5.71	2.34	-59.0	-4.54
Koffele	4.50	4.81	6.9	0.53
Regional Total	3.50	2.99	-14.6	-1.12

Sources: 1. CSA: Census supplement 1, A.A., December 1985

2. Arssi zone Agricultural Development Office: Planning and Programming Section (As computed by the writer)

* Due to lack of data the 1984 rural population figure is calculated with the cultivated land for the year 1986.

As far as the 1994 population and housing census is concerned, Arssi had 333,320(15.04%) of in-migrants from various parts of the country, out of the total population, 2,216,648 (excluding the not stated category) of the region. This clearly shows that the in-migration rate (from various regions of the country) has increased significantly by 70.9% as compared with that of 1984. Concerning area of previous residence, out of the total 333,320 in-migrants, only 57,886 (17.4%) were from urban, while the substantial amount 275367 (82.6%) were from rural areas (CSA, 1994, see also table 5.9). Among all migrant population of Arssi region, about 59% were females. However, the sex-composition is not the same in rural and urban areas. For example in case of rural to urban migration, female migrants constituted about 54.3% where as for urban to urban migration, the female migrants contributed 54.1% out of the respective migrant population (see table 5.9).

Table 5.8 Structure and Composition of Migrants and Non-Migrant Population in Arssi by Awraja,1984.

I. Migrants	Arbagugu	Ticho	Chilalo	Total Arssi
1. Inter-regional Migrants	38677	23902	82965	145544
2. Intra-regional Migrants	20084	42919	101696	164699
3. Total Inter and Intra regional migrants	58761	66821	184661	310243
4. Total population				
5. Not stated	8942	8147	17587	34676
II. Non-migrants				
6. At regional level (4)-(1)-(5)	304211	314834	879354	1498399
7. At Awraja level (4)-(3)-(5)	284127	271915	761829	1317871
III. Non-migrants + Not stated				
8. At regional level (4) - (1)	313153	322981	88112	1517246
9. At Awraja level (4)-(3)	293069	280062	779416	1352547

Source: CSA: The 1984 population and housing census, (Row data)
(As compiled by Almaz Amine (1990)

Table 5.9 In Migration rate (from various regions of the country) of Arssi by Sex and Place of Residence, 1994

Destination of Migration	Origin of Migration			
	Urban	Rural	Not Stated	Total
Urban	10.8	21.5	0.1	32.2
Male	45.9	45.7		
Female	54.1	54.3		
Total	100	100		
Rural	67	61.1	0.9	67.8
Male	52.2	37.0		
Female	47.8	63.0		
Total	100	100		
Total	17.4	82.6	1.0	100

Source: Computed from the 1994 CSA result for Oromiya, April, 1996, Addis Ababa

5.5.2 Spatial Distribution of Migrants

According to the 1994 Population and housing census, there was significant spatial disparately among the weredas of the region interms of in-migration rate. For instance, Tiyo followed by Merti and Dodata- Sire had the highest rate of in-migration with values of 30.16%, 22.66% and 21.09% respectively. On the other hand, Gololcha (8.14%) followed by Shirka (8.37%) and Sude (9.15%) experienced the lowest rate of in-migration in the region. More over, weredas such as Gedeb, Amigna, Hitosa and the like showed a moderate level of in-migration rate (see Table 5.10 and Figure 5.3).

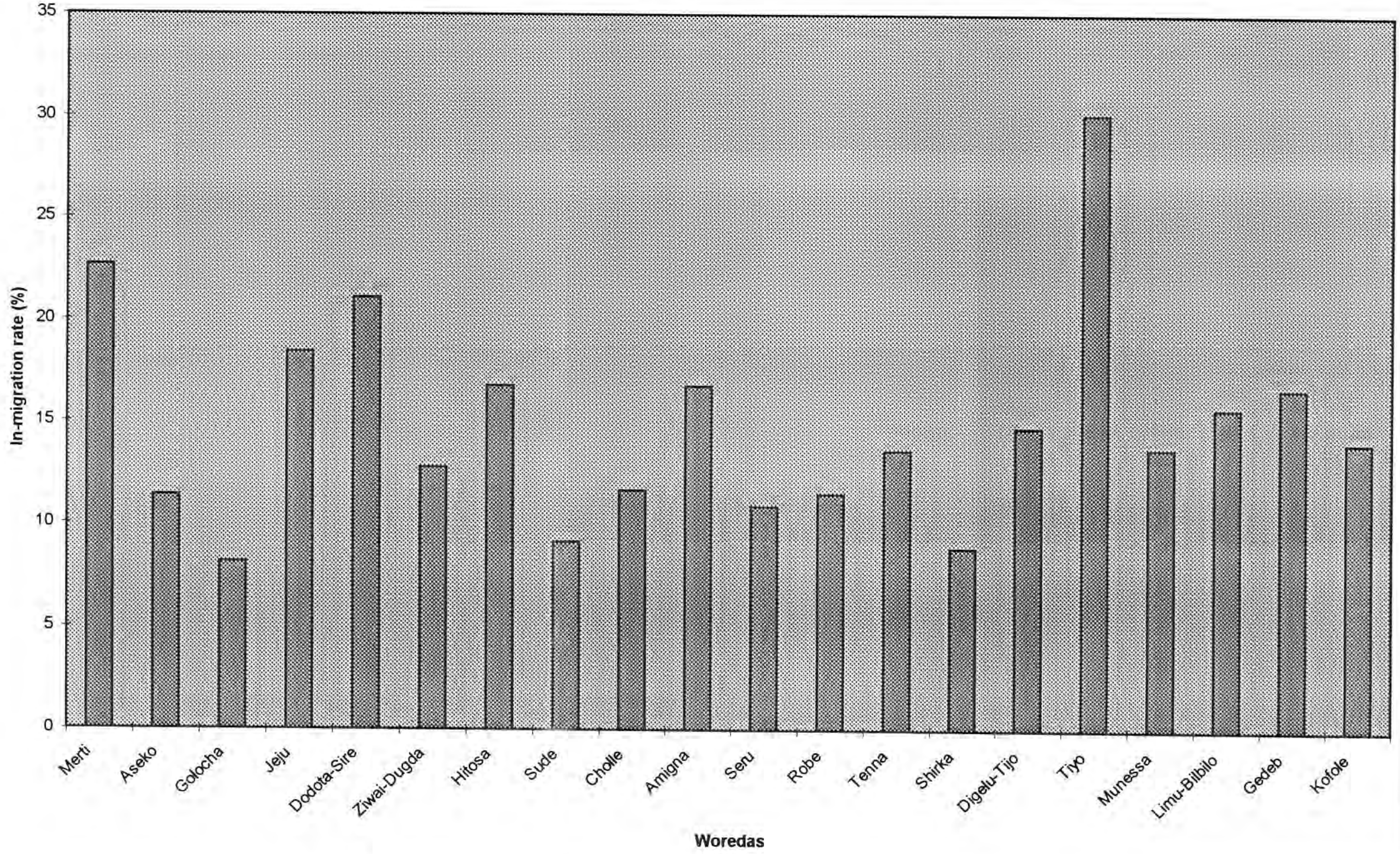
Table 5.10 In-migration Rate to Arssi by Wereda, 1994

Wereda	Total Population*	Number of In-Migrants	In-migration Rate (%)
Merti	93,827	21,263	22.66
Aseko	61,511	6,982	11.35
Golocha	117,826	9,594	8.14
Jeju	88,826	16,388	18.45
Dedota-Sire	107,820	22,743	21.09
Zewai-Dugda	86,691	11,071	12.77
Hitosa	174,254	29,284	16.81
Sude	113,635	10,400	9.15
Cholle	80,120	9,335	11.65
Amigna	54,264	9,130	16.83
Seru	80,342	8,751	10.89
Robe	118,434	13,677	11.52
Tenna	91,417	12,500	13.67
Shirka	112,741	9,434	8.37
Diglu-Tijo	104,126	15,406	14.80
Tiyo	116,985	35,286	30.16
Munessa	147,991	20,418	13.80
Limu-Bilbilo	165,766	26,134	15.77
Gedeb	120,366	20,169	16.76
Koffele	179,706	25,355	14.11
Regional Total	2,216,648	333,320	15.04

Source: CSA: The 1994 Census: Result for Oromiya Region (Raw Data)

- Total Population excludes the Not Stated Category of the Migration Status.

Figure 5.3 : Rate of In-migartion per 100 Population by Woreda, 1994



Some of the factors which might have contributed for the spatial variation in the ratio of in-migration among the weredas of the region are difference in the level of the agricultural potential of the weredas as well as proximity to major urban centres because of better transportation and communication facilities. For instance, weredas such as Tiyo, Hitosa, Gedeb and Dodota - sire have good agricultural potential and so they are important crop producing areas which could attract people from different areas. In addition, the fact that Tiyo has experienced significant rate of in-migration could be due to the fact that it is a wereda in which the regional capital city (Assela) is found. Thus, more people tend to migrate to the wereda in search of better social, economic and the like opportunities.

The general trend of the discussion in this chapter unfolds that Arssi has experienced significant development (change) interms of increase in population size and density and in-migration rate. This has been so because of the various factors discussed above. In the following chapter we shall examine the next effect of the growth of population (in size and density) on the agricultural development of the region by controlling other factors which have possible impact on the agricultural development of the region.

CHAPTER SIX

VI. Population Growth and Agricultural Development

In the previous section, chapter four, we have examined that agricultural development in Arssi is characterized by expansion in cultivated land, increase in production (except for some weredas), increased use of fertlizer, improved seeds etc. while in chapter five, the level and change in population size and density was discussed. In what follows we will examine the relationship these agricultural developments may have with population change.

6.1. Population Growth and Agricultural Intensification

The growing literature on population pressure and agricultural land fragmentation unfolds that under situations where peasants can not expand their cultivated land, they are obliged to use the already cultivated land more intensively. There are three ways by which intensive use of the existing land is possible (Ganguli, 1938). The first way is by increasing the intensity of cropping i.e. increasing the frequency of cultivating the land within a given period. The highest intensity can be attained by decreasing the fallow period to zero. Secondly, the intensive cultivation of land per crop season through increased use of labour input, and thirdly the production of more labour intensive and high productive crops.

As the intensity of cropping increases, the fallow period declines and hence the possibility of regenerating the natural fertility of soils becomes low.

Therefore, it is of paramount importance to use fertilizers and improved seeds in order to maintain the level of productivity.

The relation ship between population growth and methods of agricultural intensification such as fertlizer and improved seeds, has shown a positive association. Table 6.1 shows that population density in Arssi increased from 45.5 to 100.9 persons per square kilometre during the period between 1979/80 to 1996/97. During this period, use of chemical fertilizers and improved seeds also increased substantially. Despite the increasing trend, fertilizers and improved seeds application show marked fluctuation (ups and downs) in contrast to the ever increasing trend of population size and density. This fluctuation might have been partly due to unreliable rainfall condition (delayed and untimely rainfall) which gives rise to drought and hence a decrease in input usage in some years.

Application of improved seeds has shown marked change of about 300% between 1979/80 and 1996/97. Fertilizer application has also shown substantial increase of about 133% during the period. These changes indicate the introduction and rapid adoption of new technology to boost food production during the period when population was growing rapidly. The reasons for using increased amount of input could be due to the inability to bring more land under cultivation (see Table 6.1).

Table 6.1 Population growth and agricultural intensification in Arssi, 1979/80 to 1996/97

Year	Population		Fertilizers ('000qt)	Improved Seeds ('000qt)
	size('000)	Density		
1979/80	1119.3	45.5	93.2	3.8
1981/82	1180.4	48.0	68.5	20.7
1983/84	1616.4	68.3	82.6	12.5
1985/86	1708.1	72.1	65.9	15.2
1987/88	1820.1	76.8	171.1	3.4
1992/93	2137.2	90.3	85.6	41.5
1994/95	2217.2	96.2	213.6	17.8
1996/97	2327.0	100.9	217.5	15.2

Sources: Compiled by the writer from:

1. Statistical Abstracts
2. AISCO, South-eastern Branch Co-ordination Office

Note: Population density is calculated as persons per square kilometre

The effects of population pressure on agricultural intensification varies from one wereda to the other. This could be seen interms of the amount of modern agricultural inputs (fertilizers and improved seeds), cropping intensity (as the ratio of gross cropped area and net cropped area multiplied by 100) and the proportion of fallow land (Appendix-8).

In the 20 weredas of Arssi region, agricultural density is positively correlated with cropping intensity ($r=0.0619$), improved seeds application ($r=0.2090$) and inversely with the level of fertilizer use ($r=-0.0041$) in contrast to our expectation. Proportion of fallow land has zero correlation with agricultural density (r=0.0000). Weredas which use higher level of improved seeds and those with higher agricultural density tend to show higher cropping intensity and vise versa although the correlation is very weak.

In both cases of cropping intensity and the level of fertlizer use, the correlation coefficients are so weak that they are of no analytical significance. This implies that even though there is some what close relationship between agricultural density and intensity of cropping which confirms the positive impact of population pressure on agricultural techniques, other factors such as the nature of the physical environment (soil and climate), the amount of modern agricultural inputs used and the use of irrigation and water conservation methods need also be teken in to consideration in off-setting the positive impact of population pressure. In fact physical factors can either weaken or strengthen the impact of population growth on the intensity of cropping. It is obvious that agricultural intensification is more plausible in areas with good physical environment i.e., areas with a long growing periods or those using irrigation system which enables them to cultivate crops more than once a year, and areas which use agricultural inputs for restoring soil fertility as well as through greater usage of labour input per unit of land.

The fact that agricultural density is negatively correlated with the level of fertlizer use might have been due to the following reason. Districts with a relatively bigger family size tend to consume almost all what they have produced and so they have very limited income from market sales. Hence, they are not capable of purchasing chemical fertilizers.

The absence of correlation between agricultural density and proportion of fallow land clearly suggests that population pressure in rural areas of Arssi is not as such sevier to the extent of reducing the proportion of fallow land for there are still some arable land for expansion of cultivation.

6.2 <u>Population Density and Agricultural Productivity</u>

In traditional agriculture, land and labour are the two basic inputs which are used to produce an output. It is thus essential in a region like Arssi that productivity is measured in terms of both land and labour inputs.

Hence, the two measures of productivity used in this study are land and labour productivity. The former measures yield per unit area of cropped land, while the latter measures the output farmers obtain in return to their effort (see item 6.3.1 for definition of these terms). Population affects the return to inputs in different ways. In terms of land productivity, it induces higher productivity through the adoption of various methods of intensification such as intensive usage of labour, fertilizers, improved seeds etc. conditioned by increasing population pressure on land. In terms of labour productivity, it induces diminishing return due to greater inputs of labour per fixed unit of area as population grows.

The relation between population and agricultural productivity is examined by estimating a regression model. The following describe the variables and the justifications for selecting the variables. The variables, other than population density are control variables.

6.3 The variables and Hypothesis

6.3.1 Definition of Variables

6.3.1.1 Dependent Variables

Land Productivity (Y1):- Total output per unit area (in quintals per hectare) of major crops (cereals, pulses and oil seeds) for private peasant holdings (main season) was calculated for the year 1996/97. This data was used as a measure of land productivity.

Labour Productivity (Y2):- The measure of productivity used here is aggregate areal output per labour (in quintals per worker) for the year 1996/97. This measure is used as an index of labour productivity.

6.3.1.2 Independent variables*

Farm size (Ha) (X1): This is the size of arable land per household.

Agricultural Density (X2): This refers to rural population per hectare of cultivated land.

Fertilizer Input (X3): This is the amount of total chemical fertilizers (DAP and Urea) (kg) applied per hectare of land which is covered with temporary crops.

Improved Seeds (X4): This refers to application of improved seeds (kg) per hectare of Temporary crop land.

---

* The study is based on district level analysis which includes all the 20 weredas of Arssi (cross sectional analysis). All the variables refer to 1996/97.

Package Plots (X5): This is total number of crop package plots per crops package peasant which are functional in the Extension System.

Dummy for Dega (D1): An agro-ecological variable denoted by 1 if a district is dega, 0: otherwise.

Dummy for Woinadega (D2): An agro-ecological variable denoted by 1 if a district is woinadega, 0: otherwise.

6.3.2 **Justification for Selecting the variables and Hypothesis**

As mentioned above, seven explanatory variables representing various characteristics of farming activity of the 20 weredas of Arssi region were used for 1996/97. The explanatory variables were average land holding per household, levels of inputs, and agro-ecological characteristics. The dummy variables which are used to denote agro-ecological zones could be proxy variables for rainfall, temperature and other physical elements of a district.

These explanatory variables were selected to denote various characteristics of agriculture that are likely to have significant impacts on agricultural productivity (land and labour productivity). Two of the seven variables show the levels of inputs in agriculture. These are fertilizer input and improved seeds.

Among the seven variables, agricultural density (X2), fertilizer input (X3), improved seeds (X4), package plots (X5) and woinadega zone (D2) are expected to be positively correlated to land productivity, while farm size (X1) is expected to have a negative relation to land productivity.

The following are possible reasons why variables are positively or negatively correlated to land productivity.

Small farms are expected to be intensively cultivated than large farms because of more inputs per unit area applied to small farms, hence farm size is negatively related to land productivity.

Agricultural density leads to intensive use of land so that it is positively related to land productivity. It could also mean increased supply of labour (input) hence more output.

Fertilizer and improved seeds increase soil fertility which give rise to more land productivity.

Number of crop package plots positively affect land productivity since they are better crop lands where improved seeds are applied in considerable amount.

Woinadega zone is expected to be better in its environmental conditions than Dega zone because of its favourable climatic elements than the dega zone.

In examining the association between labour productivity and the selected explanatory variables, the following type of correlation can be expected.

Farm size is expected to be positively correlated with labour productivity, since high labour productivity in agriculture is generally associated with extensive farming rather than with intensive ones. It is also true that long-fallow system increases soil fertility and there by it gives higher labour productivity than short-fallow system. On the other hand, agricultural density is expected to be negatively related to labour productivity as it indicates greater inputs of labour per fixed unit of area.

According to Boserup's (1965, 1981) theory of 'agrarian change', families with relatively big family labour supplies will tend to get higher crop yields (due to the intensive use of labour and land). Similarly, big families will also tend to use more fertilizer and improved seeds than small families, which gives rise to higher crop yields. Variables X3 (fertilizer input) and X4 (improved seeds) thus give some implications of capital and labour inputs in agriculture and are expected to be positively related with crop production.

Two regressions were run to examine productivity patterns and the factors affecting it in the weredas, each with a different combination of dependent variables - land (Y1) and labour (Y2) productivity.

A third regression was also run to see the possible correlation between agricultural density and selected measures of the farming system in all the 20 weredas of Arssi. Taking agricultural density as the explanatory variable, four dependent variables were selected i.e, farm size (X1), fertilizer input (X3) , improved seeds (X4) and package plots (X5).

6.4 Analysis of Multiple Regression

6.4.1 Multicollinearity Diagnositics

It is of great significance to focus on diagnosing and dealing with multicollinearity in order to see the level of the interrelatedness of the independent variables before we start running the regressions.

Multicollinearity can be detected by examining Correlation matrix. The correlation matrices in tables 6.2 and 6.3 indicate that none of the independent variables have high pairwise correlations.

Table 6.2 Correlation Matrix

	Y1	X1	X2	X3	X4	X5	D1	D2
Y1	1,0000							
X1	-0.4954	1,0000						
X2	0.0744	-0.3837	1,0000					
X3	0.6647	-0.4559	-0.0041	1,0000				
X4	-0.0031	-0.3227	0.2090	0.2011	1,0000			
X5	0.2085	-0.0663	-0.1215	0.0772	0.4882	1,0000		
D1	0.5115	-0.2638	0.3419	0.3343	-0.1432	0.3629	1,0000	
D2	0.0079	-0.2027	-0.0451	0.0449	0.3305	-0.1852	-0.5345	1,0000

Table 6.3 Correlation Matrix

	Y2	X1	X2	X3	X4	X5	D1	D2
Y2	1,0000							
X1	-0.2095	1,0000						
X2	-0.1650	-0.3837	1,0000					
X3	0.6531	-0.4559	-0.0041	1,0000				
X4	-0.0006	-0.3227	-0.2090	0.201	1,0000			
X5	0.3257	-0.0663	-0.1215	0.0772	0.4882	1,0000		
D1	0.4917	-0.2638	0.3419	0.3343	-0.1432	0.3629	1,0000	
D2	-0.0906	-0.2027	-0.0451	0.0449	0.3305	-0.1852	-0.5345	1,0000

It is also important to use another method of multicollinearity diagnostic - Variance Inflation Factors (VIF) in addition to the correlation matrices presented above. This is because if independent variables have low pair wise correlations, then the examination of simple correlation coefficients does not necessarily disclose the existence of relations among groups of independent variables.

A highly useful formal method of detecting the presence of multicollinearity that is widely used is the method of VIF. these factors measure how much the variances of the estimated regression coefficients are inflated as compared to when the independent variables are not linearly related. It can be shown that the VIF for b'k (Standard Coefficients), denoted by (VIF) K, is:

$$(VIF)_k = (1 - R^2_k)^{-1} \qquad K = 1,2,\ldots, P - 1$$

where R^2k is the coefficient of multiple determination when Xk is regressed on the P - 2 other X-variables in the model.

P - 1 Independent variables - when X1, ..., X P-1 represent P - 1 different independent variables. The following table shows VIF Vs X-variables included in the regression model for b'k.

Table 6:4 Summary of VIF for b'k taken from the results of the regression analysis.

Variable	b'k (SE)	R^2k	(VIF)k
x1	0.82099	0.43775	1.779
x2	0.45355	0.43781	1.769
x3	21.13132	0.41148	1.699
x4	5.48514	0.66863	3.018
x5	0.09643	0.62282	2.652
D1	0.33727	0.59781	2.486
D2	0.49110	0.40308	1.675

Maximum VIF = 3.018

Mean (VIF) = 2.154

As far as diagnostic uses are concerned, the largest VIF value among all x-variables is mainly used as an indicator of the severity of multi-collinearity. A maximum VIF value in excess of 10 is often considered as indication that multicollinearity may be unduly affecting the least square estimates. Nevertheless, in our case all the x-variables have VIF values which are much more less than 10 (with maximum value of 3.018). This shows that none of the variables have shown sever multicollinearity in the model.

The mean of the VIF values also gives information about the severity of multicollinearity concerning how far the estimated standardized regression coefficients b'k are from the true values of regression coefficients (B'K). Thus, large VIF values result, on the average, in higher differences between the estimated and true standardized regression coefficients. However, the mean of the VIF values shown in this analysis clearly shows that there is only small differences between the estimated and true standardized regression coefficients of the model.

In sum, the discussion on multicollinearity diagnostics through the examination of simple correlation coefficients and the use of VIF unfolds that multicollinearity is not a problem in the multiple regression analysis used in the study.

6.4.2 **Land Productivity (Y1)**

A multiple correlation (R) was computed for the dependent variable, land productivity (Y1) and the selected explanatory variables. As it can be seen in table 6.6, land productivity has shown a positive multiple correlation (R=0.81016) with the explanatory variables whose coefficient of determination (R2) is 0.65636. The results suggest that about 65.6% of the variation in land productivity is explained by the seven variables. The adjusted R square reduced the explained variation to 41.58%.

Table 6.5: Analysis of variance (ANOVA) Table of Regression Model on Land productivity (Y1) and seven explanatory variables (X1, X2, X3, X4, X5, D1 and D2) In the 20 weredas, 1996/97

Sources of Variation	Degrees of freedom	Sum of squares	Mean square	F-Ratio
Model (Regression)	7	232.94502	33.27786	2.72861
Residual	10	121.95903	12.19590	
Total	17	354.90405		Signif F=0.0732

Table 6.6 Summary Multiple Regression on Land Productivity (Y1) and Seven Explanatory variables

Variables	Regression Coeff. (b)	Standard Error of Estimate	Beta Standard Coefficient (B)	Computed t-value
X1	-1.161282	1.282545	-0.223848	-0.905
X2	-0.289316	2.321578	-0.030729	-0.125
X3	0.106796	0.049829	0.517893	2.143*
X4	-0.207155	0.191965	-0.347511	-1.079
X5	9.987053	10.919088	0.276075	0.915
D1	2.639303	3.121987	0.247111	0.845
D2	2.224389	2.144080	0.248922	1.037

Multiple R=0.81016 *Significant at 0.05 level
Multiple R2=0.65636
Adjusted R2= 0.41581
Standard Error = 3.49226
Y1 (pred)= -1.6+ (-1.2X1) + (-0.3X2) + 0.1X3+ (-0.2X4) + 9.9X5 + 2.6D1 + 2.2D2

As shown in table 6.5, the computed F-value is 2.72861 (with 7 and 10 degrees of freedom) with value of (significant F= 0.0732).

The largest proportion of variation in land productivity was due to fertilizer input (X3) followed by improved seeds (X4) and package plots (X5) with Beta standard coefficients of (0.5179), (-0.3475) and (0.2761) respectively (see table 6.6).

The regression model shows that only one variable namely fertilizer input (X3) is significant at 0.05 level. The remaining variables were not found significant statistically.

In general, the above discussion clearly indicates that most of the variables could not provide a sufficient explanation of land productivity in Arssi. Apparently, yield is a function of a complex interplay of a multitude of factors other than those that have been considered in this regression analysis.

The correlation matrix in table 6.2 indicates that two independent variables namely Dummy for Dega (D1) and fertilizer input (X3) have relatively strong correlations with the dependent variable, i.e., land productivity (Y1).

Concerning our expectation, it was anticipated that farm size will be negatively related to land productivity. Although it is negatively signed in our model, it is not significant.

Agricultural density was expected to have a positive impact on land productivity. However, the variable showed positive but insignificant association with land productivity. There fore further investigation is of a great importance on this issue.

6.4.3 Labour Productivity (Y2)

Labour productivity is another measure of agricultural productivity that can be affected by demographic factors. To see their impacts, first a multiple correlation (R) was computed for the dependent variable (Y2) and the selected explanatory variables in the model.

As we can see from table 6.7, labour productivity showed a positive multiple correlation (R=0.79924) with the explanatory variables whose coefficient of determination (R2 = 0.63879) is said to be strong enough to explain the variation. The result suggest that 63.88 % of the variation in labour productivity is explained by these seven selected variables. When we examine the value of adjusted R square (0.38594), which is a more accurate measure than R square, we can clearly see that 38.59% of the variation is explained by the independent variables of the regression model.

Table 6.7:- Summary of Multiple Regression on Labour productivity (Y2) and Seven Explanatory Variables

Variable	Regressio n coffee. (b)	Standard Error of Estimate	Beta Standard Coeff. (B)	Computed t-value
X1	1.1414	3.2566	0.0888	0.351
X2	-2.8271	5.8948	-0.1212	-0.480
X3	0.2922	0.1265	0.5721	2.309*
X4	-0.3115	0.4874	-0.2110	-0.639
X5	25.8199	27.7251	0.2882	0.931
D1	9.1725	7.9272	0.3468	1.157
D2	4.5778	5.4441	0.2068	0.841

Multiple R = 0.79924 R Square = 0.63879

Adjusted R square = 0.38594 Standard Error = 8.86735

* Significant at 0.05 level

Regression equation:

$Y2\ (Pred) = -16.5 + 1.1X_1 + (-2.8X2) + 0.3X3 + (-0.3X4) + 25.8\ X5 + 9.2\ D_1 + 4.6\ D2$\

Table 6.8: Analysis of variance (ANOVA) Table of Regression Model on Labour Productivity (Y1) and Seven Explanatory variables.

Sources of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F-Ratio
Model (Regression)	7	1390.54888	198.64984	2.52639
Residual	10	786.29935	78.62994	
Total	17	2176.84823		Signif F=0.0893

Analysis of variance (ANOVA) in table 6.8 shows that the results were significant at 0.10 level with a computed F-value of 2.52639 (with 7 and 10 degrees of freedom) with value of (signif F= 0.0893).

Agricultural density was expected to have a negative impact on labour productivity. As expected, the relationship is negative but not statistically significant. In a condition of ever increasing agricultural density, the size of holding is no longer adequate to satisfy increased demand. Hence, frequent use of land needs an increase in the level of labour input. Thus, an increase in agricultural density should be accompanied by a higher use of labour. However, according to this result, it can be generalized that without change in technology and inputs used, population growth alone may not give rise to higher labour productivity and may of course have a negative impact on productivity.

Table 6.7 shows that the largest proportion of the variance in labour productivity was due to fertilizer input (X3) followed by dummy for Dega (D1) and package plots (X5) with Beta standard coefficients of (0.5721), (0.3468) and (0.2882) respectively.

The correlation matrix in table 6.3 indicates that two independent variables namely fertilizer input (X3) and dummy for Dega (D1) have relatively stronger relations with the dependent variable, i.e. labour productivity (Y2).

The lowest contribution to the variance in labour productivity was made by farm size (X1) and agricultural density (X2) with Beta standard coefficient of (0.0888) and (-0.1212) respectively.

The multiple regression analysis indicated that about 36.12% of the variation in labour productivity remained unaccounted for by the explanatory variables included in the regression model.

6.5 Regression Analysis of Agricultural Density

Simple regressions were computed to see the possible associations between the four dependent variables and one explanatory variable, agricultural density. The result of the regressions show that improved seeds is positively correlated to agricultural density while the others are negatively correlated (table 6.9).

The relationship between agricultural density and farm size is moderate (r=-0.38) and negative (consistent with our expectation) with P-value of 0.10 level of significance. This aspect of agricultural change is associated with reduction in the size of holdings, due perhaps to the increased demand for land. There are empirical evidence which indicate that population pressure is one of the main reasons for the decline in farm size. In Ethiopia a study undertaken by Abbi (1995) shows that population growth accompanied by increased food demand leads to increased land fragmentation which results in diminishing farm size. Farm fragmentation describes a condition where a farmer's land holding is broken up in to a number of small different parcels, usually far away from each other.

Agricultural density has weak relationship (r=0.209) with application of improved seeds. The correlation is positive (as expected), indicating the positive effect of increasing population on the use of improved seeds eventhough it is significant only at 0.50 level on the basis of t-test with 19 degrees of freedom.

Table 6.9 Summary of Simple Regression Results of Indicators of Farming System with Agricultural Density

Dependent variables	Independent variable	Simple Correlation Coeff (r)	Regression coeff. of b	Standard Error of b (SE b)	't' value	Level of signif.
Farm size (x1)	Agricultural density (X2)	-0.3837	-0.5101	0.2893	-1.763*	0.0949
Fertilizer input (X3)	Agricultural Density (X2)	-0.0041	-0.1395	8.0426	-0.017	0.9864
Improved Seeds (X4)	Agricultural Density (X2)	0.2090	2.3913	2.6376	0.907	0.3766
Package plots (X5)	Agricultural Density (X2)	-0.1215	-0.0316	0.0646	-0.490	0.6310

The number of observations is 20

* Significant at 0.10 level

Agricultural density has shown negative impact on both fertlizer input and package plots with correlation coefficient values of (r=-0.004) and (r=-0.122) respectively irrespective of our expectation. However, the relation ships are not significant even at P-value of 0.10 in both cases.

The negative regression coefficient, which is significant at 0.10 level according to a t-test with 19 degrees of freedom, shows that size of arable land (farm size) decreases as population pressure on cultivated land increases.

6.6 Longitudinal Analysis

To study the effects of increases in population pressure on changes in indicators of farming system overtime, two simple regressions were run between four dependent variables and two independent variables, each with a different combination of independent variables - population density (X15) and population size (X16). The four dependent variables were crop production (X11), fertilizer (X12), crop land (X13) and improved seeds (X14). Both the dependent and independent variables of the regression model are based on time series data during 1979/80-95/96 for Arssi region. The correlation matrix of these variables is shown in table 6.10.

Table 6.10:- Correlation Matrix

	X11	X12	X13	X14	X15	X16
X11	1.0000	0.7638	0.6890	0.1699	0.6299	0.6209
X12	0.7638	1.0000	0.6961	0.3476	0.7421	0.7309
X13	0.6890	0.6961	1.0000	0.5227	0.8418	0.8440
X14	0.1699	0.3476	0.5227	1.0000	0.4734	0.4844
X15	0.6299	0.7421	0.8418	0.4734	1.0000	0.9992
X16	0.6209	0.7309	0.8440	0.4844	0.9992	1.0000

6.6.1 <u>Regression Analysis of Population Density</u>

Consistent with the cross-sectional results, increase in population density has a positive (r=0.4734) impact on change in the application of improved seeds. Population density increase is also significant for positive changes in fertilizer usage, crop production and crop land. Crop land is by far the most highly correlated (r=0.8418) with 0.001 level of significance of all the dependent variables (see table 6.11 a).

In examining the proportion of variation caused by population density increase in the dependent variables, crop land (X13) has the largest proportion with Beta standard coefficient of (0.8418). This is attributed to population density increase (explaining 68.9% of the variation in crop land) with P-value of 0.001 level of significance. On the contrary, improved seeds (X14) has the lowest proportion of variation with Beta standard coefficient of (0.4734). Population density is responsible for only 17.2% of variation in the use of improved seeds with P-value of 0.05 level of significance (see table 6.11a).

In general, population density increase has been of paramount significance for positive changes in crop production, fertilizer consumption, crop land and application of improved seeds for the last 17-years during 1979/80-1995/96.

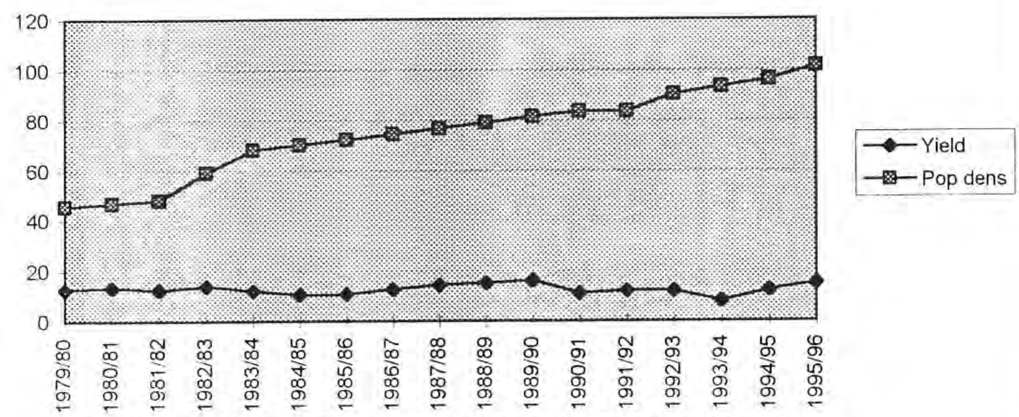
Table 6.11. Summary of Simple Regression Results of Indicators of Farming System with Population Density (a) and Population size (b)

Dependent variables	Independent variable	Simple correlation Coeff (r)	Regression coeff. of b	Standard Error of b (SEb)	't' value	Level of Sign.	Adjusted R square
Crop Production (X11)	Population Density (X15)	0.6299	51.554	16.413	3.141	0.0067	0.3566
Fertilizer (X12)	Population Density (X15)	0.7421	2.400	0.560	4.288	0.0006	0.5208
Crop land (X13)	Poplation Density (X15)	0.8418	4.367	0.723	6.040	0.0000	0.6892
Improved seeds (X14)	Population Density (X15)	0.4734	0.327	0.157	2.082	0.0549	0.1724
b)							
Crop Production (X11)	Population size (X16)	0.6209	2.279	0.743	3.067	0.0078	0.3445
Fertilizer (X12)	Population size (X16)	0.7309	0.106	0.026	4.147	0.0009	0.5031
Crop land (X13)	Population size (X16)	0.8440	0.196	0.032	6.094	0.0000	0.6931
Improved Seeds (X14)	Population size (X16)	0.4844	0.015	0.007	2.145	0.0488	0.1837

d.f = 16

On the other hand, population density can affect yield negatively. Population is one of the multitude of factors affecting yield. It exerts influence on yield through various processes such as over-cultivation, over-grazing, short fallow period and the like which in turn reduce the natural fertility and quality of soil (soil degradation). Figure 6.1 for example shows some sort of inverse relationship between population density and yield especially during the period between 1989/90-93/94.

Figure 6.1 : Trend in population density and yield overtime



Note : Population density (person per km2). Yield (quintal per hectare)

6.7.2 <u>Regression Analysis of Population Size</u>

It is also interesting to note that the effect of increase in population size on all the four indicators of farming system are positive and significant at P-value of less than 0.05 level (see table 6.11). This suggests that the region with a certain initial level of population size experienced a considerable increases in crop production, fertilizer usage, crop land and application of improved seeds during 1979/80-95/96.

Consistent with the impact of population density, population size has a positive (r=0.8440) (the highest value) impact on change in crop land with a P-value of 0.001. This represents 69.3% of variation in crop land. Of all the dependent variables, application of improved seeds is the least affected by population size increase with a slightly moderate co-relation (r=0.4844) with 0.05 level of significance. It takes a value of only 18.4% of its variation is explained by population size.

To sum up, the fact that there is very strong relation between the two independent variables - size and density of population, unfolded very similar results (in terms of magnitude of correlation) in their impacts on each of the dependent variables as it can be seen from the correlation matrix (table 6.10).

Figure 6.2 and 6.3 also show that population size increase has a similiar trend with some of the indicators of farming system although there has been some fluctuations over time. Of all the dependent variables, cropland followed by fertilizer is the most highly affected (with positive correlation) by population size. However, trend in crop production indicated substantial fluctuation over time which can be explained by factors other than population size increases such as untimely rain, delayed sowing, soil degradation and the like.

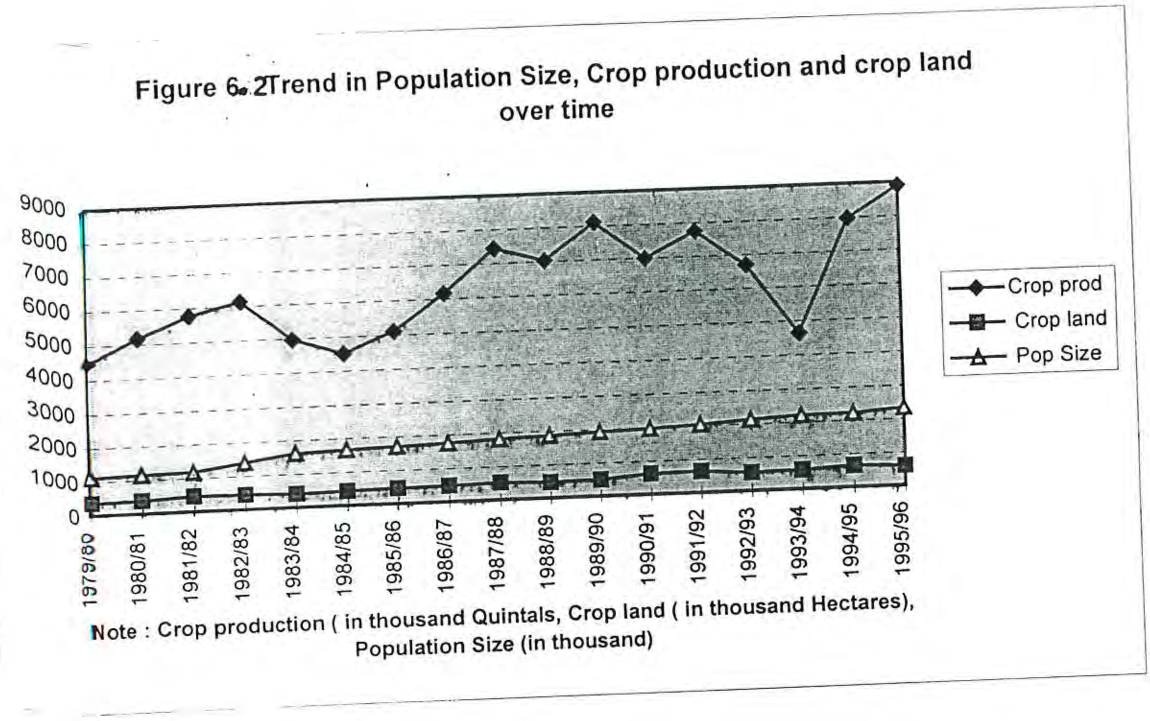


Figure 6.2Trend in Population Size, Crop production and crop land over time
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Crop prod
Crop land
Pop Size
1979/80
1980/81
1981/82
1982/83
1983/84
1984/85
1985/86
1986/87
1987/88
1988/89
1989/90
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
Note : Crop production (in thousand Quintals, Crop land (in thousand Hectares), Population Size (in thousand)

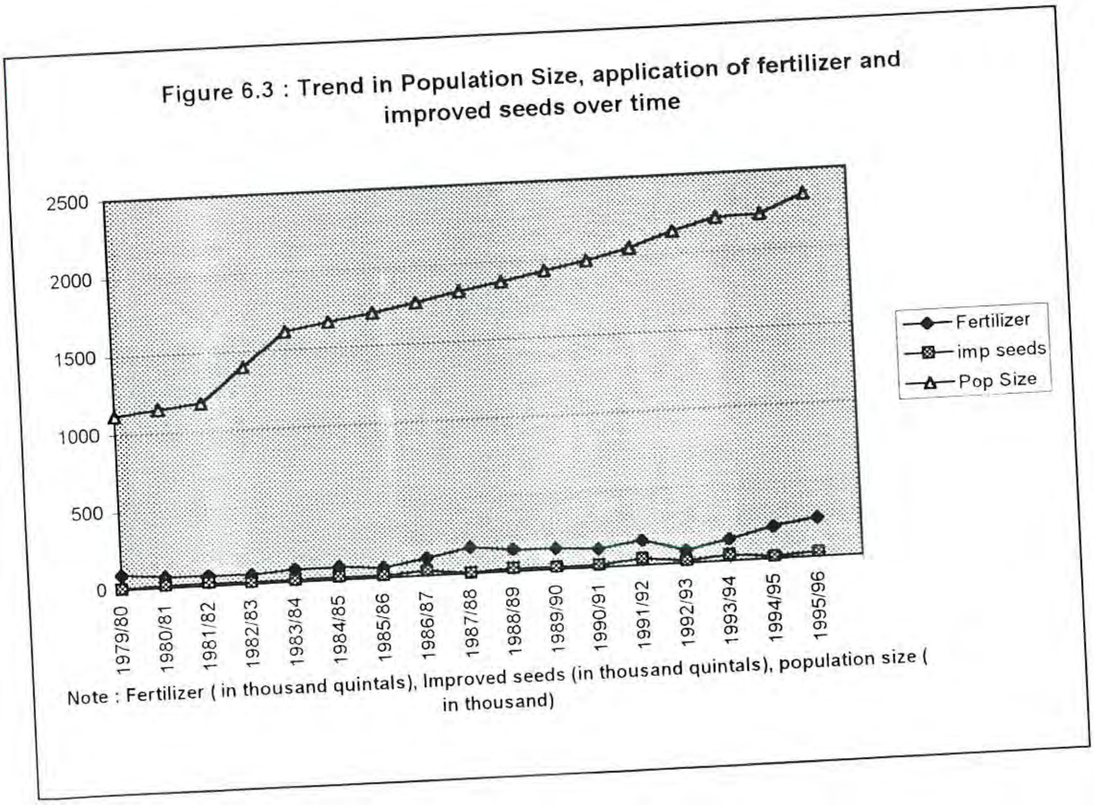


Figure 6.3 : Trend in Population Size, application of fertilizer and improved seeds over time
2500
2000
1500
1000
500
0
Fertilizer
imp seeds
Pop Size
1979/80
1980/81
1981/82
1982/83
1983/84
1984/85
1985/86
1986/87
1987/88
1988/89
1989/90
1990/91
1991/92
1992/93
1993/94
1994/95
1995/96
Note : Fertilizer (in thousand quintals), Improved seeds (in thousand quintals), population size (in thousand)

In both cases of the regressions, Arssi witnessed rapid population growth (in size and density) and substantial changes in indicators of farming system (crop land, crop production, fertilizer usage and application of improved seeds) during 1979/80-95/96. Results from the longitudinal analysis during the period reveals that increase in size and density of population has a positive effect on the dependent variables. However, these results are not consistent with the cross-sectional results, where effects of agricultural density are negative for dependent variables - fertilizer input and package plots.

CHAPTER SEVEN

VI. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1. Summary of Findings and Conclusion

The major objective of the study has been to examine the interrelationship between Agricultural Development and population pressure. The study has attempted to investigate the salient features of the interrelationships between population pressure and indicators of agricultural development such as farm size, application of fertilizers and improved seeds, cropped area; production and yield, land use pattern, land and labour productivity in Arssi region. In the following paragraphs, we discuss first a summary of the main findings of the study and second conclusions and a set of recommendations.

Farm size

The findings have indicated that cultivated land in the region were small. In 1994/95 it was estimated that the cultivated land was 1.03 and 0.20 hectares per house hold for temporary and permanent crops respectively. The region has experienced a significant increase in cultivated land (1986-97) with a percentage change of 4.67 perannum. However, the change varies from wereda to wereda. It ranges from 33.29 to - 1.81% perannum in Gedeb and Tiyo respectively.

The region had average farm size (arable land per household) of about 3.15 ha in 1996/97. However, it varies from one werda to the other. It ranges from 4.68 to 1.97 ha in Jeju and Tiyo weredas respectively. The basic reason for the disparity in farm size is attributed to differences in agricultural density. The simple correlation between the two is moderate (r=-0.384) in the cross sectional analysis.

Here, it must be emphasized at this point that there is a demographic reason for the prevalence of decreasing farm size (even though there are other factors responsible). A rapid growing rural population gives rise to problems of scarcity of farm land and limited alternative forms of employment. Nevertheless, it must be understood that the causes of variations in farm size are very complex.

In general, the findings from Arssi suggests that land holding percapita of peasant farmers is probably to decrease under the present conditions. Mini-plots of under 1 hectare are not favourable to the use of improved agricultural inputs. Consequently, diminutive land holdings percapita poses serious hindrances to improvement in agricultural production as well as the ecology of the area.

The Use of Agricultural Inputs

The study has also indicated that the application of modern inputs has been widely-practised in Arssi. However, its magnitude differs from farmers to farmers and from place to place.

The percapita fertilizer consumption of Arssi is about 31.75 kgs. Nevertheless, it varies from one wereda to the other. It ranges from 73.68 kgs per capita in Digelu to 0.98kgs in Ziwai Dugda. The analysis of aggregate data (cross-sectional analysis) has unfolded that fertilizer is by far the most significant correlates of both land productivity ($r=0.665$) and labour productivity ($r=0.653$), implying the impact of fertilizer on productivity.

It was also mentioned in the discussion that improved seeds showed very weak negative correlation with both land productivity (r=-0.003) and labour productivity (r=-0.001) unlike fertilizer in the cross sectional analysis.

Similarly Crops package plots, indicated weak and moderate positive correlations with land productivity (r=0.209) and labour productivity (r=0.326) respectively.

Land and Labour Productivity

Our study findings have revealed that the region is characterized by yearly fluctuations (ups and downs) of yields (out put/ha) over time. There is also a marked decline in yield in most of the weredas of the region although the level of application of agricultural inputs (fertilizer and improved seeds) increased considerably. Weed problems, limited crop rotation, over cultivation and overgrazing might have contributed to the declining trend in yield. Weather condition (low or untimely rainfall) is the other responsible factor for the declining trend.

The research findings have also shown substantial variation among weredas and between different agro-climatic zones in production of major crops. The differences in crop production among weredas was found to be very important. The main reason for the spatial disparity of output of major crops (temporary crops) among the weredas are the unequal distribution of farmland, variations in agricultural density, fertilizer and improved seeds inputs.

The regression analysis has shown that the most commonly associated explanatory variables with both indices of agricultural productivity used in this study are fertilizer input and Dummy for Dega.

A multiple correlation (R) was computed for seven independent variables and land productivity (Y1) which indicated that land productivity has a positive multiple correlation (R=0.8102) with the explanatory variables whose coefficient of determination (R2) is 0.6564. The result suggests that about 65.6 percent of the variation in land productivity is explained by the seven variables.

The regression model shows that the use of fertilizer has been the single most important variable explaining land productivity at 0.05 level of significance. The remaining variables are not found significant statistically.

It was hypothesized that farm size would negatively affect land productivity. Although it is negatively signed in our model, it is not significant.

Agricultural density was expected to have a positive impact on land productivity. However, the variable showed positive but insignificant association with land productivity.

Likewise, the analysis has indicated that labour productivity is associated with the explanatory variables more or less under the same situations as land productivity, i.e. higher usage of fertilizers per hectare of cultivated land, higher yield of crops in Dega agro climatic zone and the like. Labour productivity showed a positive multiple correlation (R=0.799) with the selected explanatory variables whose coefficient of determination (R^2=0.639) is said to be strong enough to explain the variation. The result suggests that 63.88% of the variation in labour productivity is explained by the selected explanatory variables.

More or less, the general direction of relation ships are as expected with the exception of few variables. In contrast to our expectation, farm size is negatively correlated with labour productivity. Although it is weak, improved seeds application is also negatively associated with land productivity.

In sum, it can be concluded that in Arssi, both land and labour productivity are low.

Cropping Pattern

The study has also presented that the cropping pattern of the region is characterized more by diversification than specialization. Nevertheless, some crops like wheat and barley are dominant than the others, the main determining factor being agro-climatic conditions.

Population

Population density is higher and ever increasing in Arssi. The agricultural density (rural population per hectare of cultivated and) is 2.99 in 1997. At wereda level, however, it varies from 4.81 to 2.13 persons per hectare of cultivated land in Koffele and Merti respectively. Such a population concentration has already yielded in a higher pressure on agricultural land.

The rate of natural increase is also high in the region with value of 2.8% per annum. It ranges between 5.8 and - 1.17% per annum in Hitosa and Dodota- Sire weredas respectively.

The regression analysis of population Density (longitudinal analysis) showed that increase in population density has a positive (r=0.473) impact on change in the application of improved seeds. Population density increase is also significant for positive changes in fertilizer usage, crop production and crop land. Crop land is by far the most highly correlated (r=0.842) with 0.001 level of significance of all the dependent variables.

Population size also has a positive (r=0.844) impact on change in crop land with a P-value of 0.001. This represents that 69.3 percent of variation in crop land is expressed by increase in population size.

Results from longitudinal analysis (Regression analysis of population density and population size), reveals that increase in size and density of population has a positive effect on the dependent variables. However, these results are not consistent some what with the cross-sectional results, where effects of agricultural density are negative for dependent variables-farm size, fertilizer input and package plots.

Migration

Migration, especially in-migration is an important factor of population growth in Arssi. It is indicated in the study that the level of in-migration from various regions of the country rose from 8.8% in 1984 to 15.4% in 1994, which accounts for 70.9% of increase of in-migration rate. At wereda level, in-migration rate varies from 30% (the highest) to 8.14% (the lowest) in Tiyo and Gololcha respectively in 1994.

7.2. Recommendations

The findings of the study can suggest several policy measures:

1. It was examined that farmsize is negatively correlated to land productivity in the study area. This shows that there is a tendency of

increase in land productivity with decreasing farm size. This is due to a relatively higher intensification in smaller plots. This is a situation that need be considered especially as population pressure on land increases time after time there by limiting any further expansion of crop land.

Population is increasing in the region due to both in-migration and natural increase (births - deaths). Hence, this condition is leading to ever diminishing of farm size and scarcity of extra cultivable land. Thus, this problem forces us to search for efficient methods of intensifying the cultivation which could be materialised by:

a) Increasing the cropping intensity which means cultivating two or more crops per year on the same farm plot. This will need supply of the requisite amount of water, better control over water, which can be implemented by flood control and irrigation schemes i.e. expansion of irrigation facilities which allows cultivation of crops more than once a year in the region in order to improve agricultural productivity.

b) The intensive cultivation of land per crop season through increased use of labour input. The fact that Arssi has experienced substantial growth in population size and density exclusively indicate the existence of sufficient labour force supply. This situation facilitates increase in aggregate out put of crops and paves the way for cultivation of more labour intensive and high productive crops through the application of increased labour input per unit of land.

c) The situation of almost entire dependence on cereals should be minimized through the production of more labour intensive and high productive crops. For instance there is enset production in Kofele wereda, which is the most populous of all weredas of the region. This shows the high population carrying capacity of the land in the enset growing areas. Because of the high productivity of enset, land under enset is found to carry 2.7 times more people than land under other food crops (Assefa et al, 1995). Farmers in other weredas of the region where there is high population pressure need also be encouraged to cultivate enset (which has high supporting capacity and less areal coverage). It can also be cultivated especially in the dry lowland areas in Arba-gugu for it is also a drought resistant crop.

2. The analysis and interpretation of the study has also shown that yield and population density have been exhibiting declining and increasing trends through time respectively. This might have been partly due to soil degradation problem which could partly be caused by increased population pressure on land which leads to conditions like overgrazing, over-cultivation, deforestation etc. In order to alleviate such problem, conservation measures practised in the region must be carried out at a larger scale. This needs the co-ordinated efforts of the extension services of the Zonal (Arssi) agricultural development unit and community participation.

3. Due to ever increasing population size, there is high competition over land uses and so there has been great deforestation which brought about environmental degradation with it. This problem calls for efficient land use planning which has high importance for proper utilization of

resources and also for mitigating the disturbances of farming activities and environmental degradation. Hence, land use policy in the region should incorporate:

a) Remodelling of the current land use system
b) The consolidation schemes which enables to bring the scattered plots to unified farm stead.

4. The use of fertilizers and improved seeds are not explained by population pressure alone. So it is important to consider other physical factors such as soil, climate, the use of irrigation and water conservation methods as well which can off-set the positive impact of population growth on the intensity of cropping. It is obvious that agricultural intensification is more plausible in areas with good physical environment i.e., areas with a long growing periods or those using irrigation system.

5. The findings from this study though limited could be used for the rural development planning of the country in general and Arssi in particular. On the bases of the evidence that in migration is ever increasing in Arssi, recognizing the agricultural potential of the region as compared with the other regions and realizing the serious problem of drought in the north, it would be relevant to encourage the prevailing trend of voluntary mobility by:
   a) Launching integrated rural development projects so that migrants would benefit from employment
   b) Development of private farms and agro-industries that process agricultural out puts would be ideal to create job opportunities for migrants and simultaneously contribute to the GDP of the country.

6. Finally, this is a study of population pressure and Agricultural Development in the 20 weredas of Arssi region. It would not be wise to draw conclusions for Ethiopia as a whole by examining only 20 weredas in a region. Hence, the results of this study could be taken as indicative, rather than conclusive.

7.3. Future Research Needs

Because of the incompleteness and limitations inherent in this study and requirement for improvement, future research needs are of a great importance.

As they are used in the analysis, the consideration of only some demographic, economic and agro-ecological variables could not explain agricultural development in the region well. As a result, the future related research needs to include the following factors:

1) Data acquisition: - Studies regarding population pressure and agricultural development need time series data. But availability of such a data from secondary sources alone is incomplete, for there are multitude of factors that affect agricultural development in addition to population variables. Even the available data are some times of low quality and from different sources which could lead to data in consistency. Thus, in order to alleviate such problems, the collection of adequate, complete and reliable data by the concerned institution for every year is recommendable.

2) Future studies would consider researches that systematically analyze the relationships between population pressure and growth on changes in agricultural practices so that the manner and

direction of linkages between population pressure and land use changes could be investigated in detail.

As far as migration studies is concerned, future studies that would focus on survey data rather than census data are required to be used because specialized survey on migration would be in a position to capture the changing characteristics of migrants, the social and economic changes that are taking place. This is so because it is easier to repeat surveys over time and places than conducting census since the former is small in scale and less costly and therefore can be launched easily, it would be appropriate to use survey data for future studies of migration. Thus, by studying characteristics of migrants from survey data one can get deep insight into the nature of changes that are happening in the place of destination and origin.

REFERENCES

Abbi Mamo, (1995), "Environment, Population and Agricultural Development in Ethiopia," in Dejene and Mulat, eds., Ethiopian Agriculture, op. cit, 1995

Alemneh Dejene (1987), Peasants, Agrarian Socialism and Rural Development in Ethiopia, Boulder: Westview Press.

Almaz Amine (1990), Differentials and Correlates of International Migration in the Arssi Region of Ethiopia, un published Master Thesis, DTRC, Addis Ababa University.

Amare G/Egziabher (1995), Resource Allocation in Small Scale Farming Under Risk in Arssie, Ethiopia: Rural Development in Africa, Asia, and Latin America, Studies 48, Rothenburg.

Assefa Hailemariam, Hussiein A., Gavi-Johan R. and Lemma K. (1995), Spatial Presentation of various Demographic and Social Characteristic of Ethiopia, Addis Ababa: Addis Ababa University Press.

Belayneh Asfaw (1987), Livestock Development in Arssi with Special Reference to ARDU. Addis Ababa, Addis Ababa University.

Bilsborrow R. (1987), "Population Pressure and Agricultural Development in Developing Countries: A conceptual Framework and Recent evidence." World Development, vol. 15, No.2

Bilsborrow, Richard E. and Martha Geores (1994), "Population change and Agricultural Intensification in Developing Countries." pp. 171-207 in Population and Environment: Rethinking the Debate, (eds.) L.Arizpe, M.P. Stone, and D.C. Major. Boulder, Colorado: Westview Press.

___(1993), "Population, Land use and the Environment in Developing Countries: What can we learn from cross-national Data?" The population Association of America Annual Meeting, April 1-3, 1993 (cincinnati).

Boserup, Ester (1965), The conditions of Agricultural Growth, Chicago: Aldine.

___ (1981), population and Technological Change: A study of Long - Term

Trends, Chicago: University of Chicago Press.

Brush, S.B., and B.L. Turner II (1987), "The Nature of Farming Systems and View of Their Change." In Comparative Farming Systems,

Chaudhury, R. (1981) "Population Pressure and Agricultural Productivity in Bangladesh "The Bangladesh Economic Review.

Cleaver, K.M. and G.Schreiber(1992), The Population, Agriculture and Environment Nexus in Sub-Saharan Africa. Washington, D.C.: World Bank Working Paper, No.6.

CSO (1975), Statistical Abstract, Addis Ababa

CSO/CSA(1977), Ethiopia: Statistical Abstract.

CSA (1984), Time Series Data on Area, Production and Yield of Principal Crops by Regions-1979/80-1983/84. Addis Ababa

__ (1988), The 1984 Population and Housing Census: Analytical Report on Arssi Region, Addis Ababa

__ (1990), Statistical Abstract, Addis Ababa.

__ (1995), Statistical Abstract, Addis Ababa

__ (1994), Statistical Abstract, Addis Ababa

__ (1995), Agricultural Sample Survey 1994/95: Report on Land Utilization (Private Peasant Holdings). volume IV, Addis Ababa.

__ (1996), The Population and Housing Census: Result for Oromiya Region, Volume I, Statistical Report, Addis Ababa.

__ (1994/95), Time Series Data on Yield of Major Crops, 1979/80-1994/95, Unpublished raw data.

Dasgupta, Partha (1992), "Population, Resources and Poverty." Ambio 21(1): 95-101.

Davis, Kingsley (1963), "The theory of Change and Response in Modern

Demographic History." Population Index 29:345-66.

Dejene Aredo (1986), "Some aspects of Agrarian Population and Land use in Ethiopia", Proc. Third Ann. Semin. Dept. Hist., A.A.U.

English, John C. (1992), "Land Resource Management in Machakos District, Kenya, 1930-1990". Washington,D.C.: Policy and Research Division, Environment Department, The World Bank.

Fassil Gebre-Kiros (1980), "Agricultural Land Fragmentation: A Problem of Land Distribution Observed in Some Peasant Association". Ethiopian Journal of Development Research. 4.2:1-12.

Findlay A. and Findlay A. (1987), Population and Development in Third World, Great Britain, Methuen.

Ganguli, B.N. (1938), Trends of Agriculture and Population in the Ganges Valley, London, Methuen and Co. Ltd.

Grigg, D (1980), Population Growth and Agrarian Change, Cambridge University Press, Cambridge.

Heilig, Gerhard K. (1994), "Neglected Dimensions of Land-use change: Reflections on Data." Population and Development Review 20(4) 831-60

Kebede Yadetie (1996), Fertilizer Distribution and Consumption in Arssi, Unpublished B.A. Thesis, Addis Ababa University.

Kumar, Joginder (1973), Population and Land in World Agriculture: Recent Trends and Relationships. Berkeley, California: Population Monograph Series No. 12. Institute of International Studies, University of California at Berkeley.

Lee, R.E. et al. (eds) (1991), Population, Food, and Rural Development, Carendon Press, Oxford.

Lele, Uma J. and Steven W. Stone (1989), Population Pressure, the Environment, and Agricultural Intensification: Variations on the Boserup Hypothesis. Washington, D.C.: The World Bank.

Leone T. (1974), Population Growth and Economic Development in the Third

World, Volume I, Liege: Iussp.

Markos Ezra (1997), Demographic Responses to Ecological Degradation and Food Insecurity. Amsterdam: PDOD Publications.

Mengistu Wube (1986), Problems of Land Reform Implementation in Rural Ethiopia: The Case of Dejen and Wolmera Districts. Doctoral Dissertation at Upsala University, Sweden.

Mesfin W.Mariam (1986), "Ethiopia's Food Scarcity: Problems and Prospects". A paper presented to the National Workshop and Food Strategies in Ethiopia, Alemaya.

Mishra, Vinod (1996), "Population Growth and Agricultural Intensification In Post-Independence India" A paper prepared for presentation at the Annual Meeting of the Population Association of America, May 9-11,1996, New Orleans.

MOA (1984), General Agricultural Survey: Preliminary Report 1983/84, Addis Ababa.

MOA (1988), Annual report (Amharic Version). Addis Ababa.

Mulat Demeke (1989), The Production Efficiency of Food Grain Producers in Ethiopia: The Case of Some Farmers in Arssi Province, Ph.D. Thesis, University of Strathclyde.

Muluneh Wold Tsadik (1994), Population Pressure, land use change and patterns of Agricultural Productivity in Ezana Wollene and Cheha Woredas, Sabat-bet Gurage land, M.A. Thesis, Addis Ababa University, Addis Ababa.

Ominde, S.H. and Ejiogu, C.N. (eds) (1981), Population Growth and Economic Development, Heinemann Publishers, London,

OPEDB (1997), Regional Atlas of Oromiya; Physical Planning Department, Finfinne.

Perkins, Dwight H. (1969), Agricultural Development in China, 1368-1968, Aldine Publishing Company, Chicago.

Population Reference Bureau (1997), World Population Data Sheet: Demographic

Data and Estimates for the Countries and Regions of the World, Washington, D.C.

Rigg, Johathan (1986), "Innovation and Intensification in N.E. Thailand:Brookfield Applied", Pacific View Point, 27.1:29-46.

Saigal, J.G. (1973/74), "Population Problem and Economic Development: A critique of Neo-malthusianism from a Marxian Approach" Lecture Notes for M.A. students of the UN Regional Institute for Population Studies, University of Ghana.

Seleshi Sisay (1982), "Swedish development Aid Policy: A Discussion with Reference to Ethiopia" Public Adminstration and Development, vol.2

Seyfu Ketema (1989), "Food Self-sufficiency and the Role of Tef," in the Proceedings of the National Workshop on Food Strategies for Ethiopia, Addis Ababa.

Solomon Mulugeta (1990), "Aspects of Fertilizer Distribution and use in selected peasant Associations in Northern Shoa," in Ege, s.(ed) Ethiopia; Problems of Sustainable Development, Working Paper on Ethiopian Development, No.5

Teshome Mulat (1992), Agricultural Taxation in Ethiopia: Agricultural Taxation Studies, FAO4, Rome:FAO

Tesema Bekele (1997), The Economic Geography of Arssi Zone: an over view, unpublished, Assela.

Tesfaye Tafesse (1990)," Marketing, Pricing, and the Peasantry; The case of Qewet Woreda, Northern Shoa", in Ege S.(ed) Ethiopia: Problems of Sustainable Development, Working Paper on Ethiopian Development, No.5.

Tiffen, M. and M. Mortimore (1992), "Environment, Population Growth and Productivity in Kenya: A case Study of the Machakos District." Development Policy Review 10:359-87.

Turner, B. L.II, R.Q. Hanham, and A.V. Portararo(1977), "Population Pressure and Agricultural Intensity." Annals of the Association of the American Geographers 67(3):384-96.

Turner, B.L.II, David Skole, Steven Sanderson, Gunther Fischer, Louise Fresco, and Rik Leemans. (1995), Land-Use and Land-Cover Change: Science/Research Plan. IGBP Report No.35 and HDP Report No.7 Stockholm and Geneva: The International Geosphere-Biosphere programme: A Study f Global Change (IGBP) of the International Council of Scientific Unions (ICSU) and The Human Dimensions of Global Environmental Change Programme (HDP) of the International Social Science Council (ISSC).

Vosti, Stephen A., Julie Witcover, and Michael Lipton (1994), The impact of Technical Change in Agriculture on Human Fertility: District-Level Evidence from India. Washington,D.C.: International Food Policy Research Institute, EPtD Discussion Paper No.5.

Westphal, E(1975), Agricultural System in Ethiopia. Wageningen: Centre for Agric. Publishing and documentation.

World Bank (1984), Toward a Sustained Development in Sub-Saharan Africa, Washington, D.C.

Appendix 1

Monthly Rainfall Distribution Pattern in Arssi

No. Area	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Average
1. Arata	0.0	12.8	74.8	48.0	79.5	102.8	145.9	122.3	103.3	25.5	6.8	0.1	722.8	60.2
2. Asasa	21.5	39.8	40.7	49.5	39.4	64.8	123.1	169.6	48.2	20.3	7.0	9.8	633.7	52.8
3. Asela	28.4	50.9	104	116.4	110.5	148.6	206.9	241.7	178	54.9	16.3	5.8	1,262.4	105.2
4. Bekoji	0.0	7.5	56	60.5	72.8	134.5	188.1	193.1	108.8	61.1	8.3	12.4	903.1	75.2
5. Kofele	25	63.8	105.3	155.6	92.1	96.1	139.2	163.4	140.9	95.2	50.8	11.3	1,138.7	94.8
6. Kulumsa	29.4	43.9	71.7	53.5	80.2	89.4	138.1	142.7	118.7	20.7	14.5	5.1	807.9	67.3
7. Munessa	20.4	52.0	113.3	110.2	121.4	141.7	186.6	175.8	204.7	76.8	17.8	27.3	1,248	104
8. Sire	8.6	10.3	77.6	62.7	51.5	65.8	138.8	192.7	164.6	68.5	6.3	5.5	852.9	71.1
9. Diksis	57.4	63	72.4	88.9	44.9	98.2	156.2	174.9	133.6	82.3	21.7	20.8	1,014.3	84.5
10. Limu	43.4	102.5	83.1	106.7	127.6	141.6	293.9	259.6	142.3	68.1	61.4	13.6	1,443.8	120.3
11. Tibila	14.8	76.7	92	68	62.1	87.8	185.6	190.3	89.1	18.2	65.6	39.6	989.8	82.4
12. Minneh	26.3	13.6	91.3	136.4	116.6	114.6	186.7	165.6	141	60.4	13.1	23.6	1,089.2	90.7
Average for Arssi	22.9	44.7	81.8	88	83.2	107.2	174	182.6	131.1	54.4	24.1	14.6	1,008.6	84.05

Source: National Revolutionary Development Campaign: Arssi: A physical and Socio Economic, Profile) Physical Planning Dept., 1983, Assela

Appendix - 2

Land Use Pattern of Arssi Region at Wereda Level, 1997

Wereda	Arable Land (ha)	Forest land(ha)	Grazing land (ha)	Others (ha)	Total Area (ha)
Robe	62,711	1582	6061	57146	127500
Zewai-Dugda	52,072	1800	6347	64881	125100
Tena	38,495	8632	5998	23875	77000
Seru	45,528	75,747	49718	43007	214000
Amigna	29,305	12,194	26710	64091	132300
Munessa	38,122	49,094	34178	18106	139500
Tiyo	26,891	2,329	13120	22660	65000
Dodota-Sire	69,200	4,756	11911	59608	101000
Hotosa	61,721	5,426	18665	29688	115500
Jeju	54,105	4,482	13413	5000	77000
Gololcha	43,043	47,949	38499	41309	170800
Kofele	55,400	3,557	33762	17981	110700
Shirka	52,677	3,723	9200	42700	108300
Gadeb	60,351	399	37610	9940	108300
Lemu-Bilbiolo	76,847	3,317	35675	35761	151600
Digelu-Tijo	40,150	11,417	11591	21042	84200
Sude	59,819	11,064	35047	26370	132300
Cholle	44,608	6,344	9254	10794	71000
Aseke	20,639	9,044	15467	17450	62600
Meriti	42,885	37,978	34297	17140	132300
Total	974,569	300,834	442,023	628549	230,6000

Source: Arssi Zone Agricultural Development Office: Planning and Programming Section, Assela

Appendix -3

Area, Production and Yield of Major Crops (for main season) for Private Peasant Holdings, by Wereda, 1996/97

Wereda	Total Area (ooo'ha)			Production (000'QT)			Yield (Qt/Ha)		
	Cereals	Pulses	Oil seeds	Cereals	Pulses	Oil seeds	Cereals	Pulses	Oil seeds
Merti	16.858	2.680	0.665	73.280	8.834	1.851	4.3	3.3	2.8
Jeju	32.328	5.243	2.135	242.781	11.669	4.808	7.5	2.2	2.3
Aseko	6.366	1.224	0.545	35.178	4.423	1.635	5.5	3.6	3
Cholle	17.786	6.249	0.647	252.373	35.855	1.377	14.2	5.7	2.1
Gollelcha	23.810	0.278	-	135.106	0.684	-	5.7	2.5	-
Tenna	20.009	2.105	1.355	168.860	2.757	1.941	8.4	1.3	1.4
Sude	25.380	3.915	3.965	108.545	7.135	3.965	4.3	1.8	1
Seru	27.211	0.551	0.517	204.304	0.551	0.929	7.5	1	1.8
Robe	27.963	2.825	2.883	294.368	11.975	4.986	10.5	4.2	1.7
Amigna	13.409	1.213	2.620	110.287	1.213	2.620	8.22	1	1
Ziwai-Dugda	27.133	4.746	-	85.875	4.358	-	3.2	0.9	-
Hetosa	42.395	5.002	0.910	221.307	21.963	2.100	5.2	4.4	2.3
Munessa	34.024	2.149	0.887	486.954	13.107	2.053	14.3	6.1	2.3
Dodota-Sire	42.462	5.719	0.843	249.081	9.244	2.673	5.9	1.6	3.2
Gedeb	39.369	1.210	4.800	763.816	6.110	4.800	19.4	5.0	1.0
Koffele	24.226	2.934	1.130	287.175	15.736	2.260	11.9	5.4	2
Lemu-Bilbiolo	42.836	3.160	4.536	467.339	7.574	9.888	10.9	2.4	2.2
Shirka	24.450	3.985	0.352	158.452	3.638	0.935	6.5	0.9	2.7
Digelu-Tijo	33.347	2.775	2.636	674.36	12.400	9.400	20.2	4.5	3.6
Tiyo	16.305	3.245	0.320	208.285	9.615	1.035	12.8	3.0	3.2
Total	536.656	61.193	31.346	5572.516	196.153	59.237	10.4	3.2	1.9

Source:Arssi Zone Agricultural Development Office, Assela

Appendix -4

Change in the production (Qt) of Cereals Over Time

by Wereda (1982/83-1996/97)

Wereda	1982/83[1]	1996/97[2]	% Change	% Change/ annum
Merti	219359	73280	-66.6	-4.76
Jeju	235521	242781	3.1	0.22
Aseko	78111	35177.7	-54.9	-3.92
Cholle	181356	252373	39.2	2.8
Golollecha	207773	135106	-34.9	-2.49
Tenna	163675	168860	3.2	0.23
Sude	221535	108545	-51	-3.64
Seru	153716	204304	32.9	2.35
Robe	140412	294368	109.6	7.83
Amigna	135843	110287	-18.8	-1.34
Ziwai-Dugda	212617	85874.95	-59.6	-4.26
Hetosa	458764	221307	-51.8	-3.7
Munessa	282516	486954	72.4	5.17
Dodota-Sire	607087	249081	-58.9	-4.21
Gedeb	173652	763816	339.9	24.28
Koffele	166256	287175	72.7	5.19
Lemu-Bilbilo	209005	467339	123.6	8.83
Shirka	309083	158452	-48.7	-3.48
Digelu-Tijo	244409	674362	175.9	12.6
Tiyo	226315	208285	-7.9	-0.56
Total	4627005	5572516	20.4	1.46

Soruce: 1. MOA, 1984 General Agricultural Survey, A.A.

2. Arssi Zone Agricultural Development Office, Assela

Appendix 5

Proportion of farmers using improved seed, fertilizer and average house hold fertilizer consumption, 1982/83

Location		Faremrs using	Total Fert. Consumption	Average Fertilizer Consump.	Farmers seed
Awraja	Woreda	%	%	(kgs)	%
Total		47	100	31.75	21
Arba-gugu		31	12.6	19.51	20
	Guna	52	2.6	31.25	54
	Merti	14	0.5	6.25	6
	Jeju	54	6.1	41.35	25
	Asseko	12	0.3	3.68	35
	Chole	55	3.1	29.59	17
	Golelecha	-	-	-	-
Ticho		37	11.8	16.92	15
	Tenna	21	1.3	11.21	4
	Sude	31	3.4	16.35	11
	Seru	46	0.4	3.28	32
	Robie	25	2.1	13.46	17
	Amigna	81	4.6	46.63	15
Chilalo		56	75.6	41.81	23
	Z. Dugda	2	0.1	0.98	4
	Hetossa	91	12.3	58.57	37
	Muness	63	8.3	41.37	22
	Gedeb	62	5.4	38.95	8
	Koffele	44	6.1	31.73	-
	Lemu	65	8.8	50.48	58
	Sirka	36	4.3	22.78	22
	Digela	61	12.1	73.68	68
	Tiyo	80	8.5	68.63	26
	Sire	62	7.0	39.90	-
	Dodeta	31	2.7	26.92	-

Source: General Agricultural Survey, Preliminary Report 1983/84, volume II, pp-99., Addis Ababa

Appendix - 6

Improved seeds sales outside and Inside the Extensiion package programe in Arrsi in 1997

Woreda	Maize (qts)	Wheat (qts)	Barley (qts)
Tiyo	6.9	437	334
Hetosa	9.6	3954.5	24.4
Dedota-Sire	1.9	1331.3	210
Zwai-Dugda	54.5	145.3	-
Digelu-Tijo	-	623.3	970
Munessa	16.5	482	269
Lemu-Bilbilo	-	816.3	658.1
Shirka	1.4	89.5	100.0
Gedeb	-	1248.8	34.0
Kofele	-	158.3	190.4
Sude	1.9	3.0	-
Robe	16.2	263.8	9.4
Tenna	2.1	319.5	82.5
Amigna	0.8	388.4	-
Seru	1.25	323.3	24.4
Jeju	4.5	1057.3	5.0
Merti	6.6	217.5	-
Chole	5.9	137.3	55.6
Aseko	2.2	32.3	-
Golocha	38.4	-	-
Total	169.5	12028.1	2966.8

Source: Ethio-Italian cooperation: Rural Development Project: The extension System in Arssi Zone Draft Report, January 1998, Assella

Appendix-7

Cultivated Land (Rainfed Plus Irrigated), Total Irrigated Area and its percentage Share by Wereda, 1985/86

Woreda	Cultvated Land (Ha)	Irrigated Land	
		Area (Ha)	%
Robe	16573.25	1.25	0.0075
Zewai-Dugda	34072.2	108.2	0.3176
Tenna	25707.5	522.5	2.0325
Seru	15355	155	1.0094
Amigna	11128.4	-	-
Munessa	18370	-	-
Tiyo	24799.75	179.75	0.7248
Dodota	22429.23	15	0.0669
Hitosa	31696	-	-
Jeju	7719	-	-
Golocha	18003.69	-	-
Kofele	24518.5	-	-
Shirka	33651	92	0.2734
Gedeb	12772.6	-	-
Limu-Bilbilo	30884	92	0.2979
Digelu-Tijo	23260.6	-	-
Sude	25369.6	-	-
Cholle	8033	33	0.4108
Aseko	13775	105	0.7623
Merti	15330	30	0.1957
Guna	12571	31	0.2466
Sire	25964	14	0.0539
Arssi	443974.63	1373.7	0.3094

Soruce: South-Eastern Agricultural Development Zone Annual Report: SEAD publication No.1, 1986, Assela

Appendix 8

The Relationship Between Population Density, Cropping Intensity, Application of Modern Agricultural Inputs and Proportion of Fallow Land, 1997.

Wereda	Agricultural Density	Cropping Intensity(%)	Fertilizer application (%)	Improved seeds application (%)	Proportion of fallow land (%)
Meri	2.13	130.3	23.25	1.1	7.00
Jeju	2.51	112.3	21.47	2.69	28.19
Aseko	3.40	108.4	1.75	0.42	4.82
Cholle	2.70	104.2	12.57	0.81	39.43
Gollelcha	3.48	100.0	0.02	0.17	20.93
Tenna	3.09	107.0	42.71	1.72	27.35
Sude	2.54	108.9	18.31	0.01	40.25
Seru	2.63	109.0	37.16	1.23	30.14
Robe	3.17	107.1	26.30	0.83	42.98
Amigna	2.76	109	21.62	2.26	34.45
Ziwai-Dugda	3.30	100.0	3.10	0.63	39.45
Hetosa	3.10	106.6	63.77	8.26	19.93
Munessa	3.56	113.5	60.31	2.10	1.64
Datota-Sire	2.29	109.6	31.12	3.15	28.90
Gedeb	2.34	100.6	26.98	2.83	1.33
Koffele	4.81	101.6	20.45	1.23	35.98
Limu-Bilbilo	3.56	100.4	53.32	2.92	40.89
Shirka	3.70	106.1	32.90	33.57	44.42
Digelu-Tijo	2.48	101.5	65.81	4.11	3.47
Tiyo	3.31	101.5	71.64	3.91	26.11
Regional Total	2.99	108.0	34.57	2.41	27.57

Sources: 1. Arssi Zone Agriucltural Development Office Assela
2. Ethio-Italy Rural Development Project: Mission for the Assessment of the Extension system in Arssi

DECLARATION

I, the undersigned declare that this thesis is my work and all sources of materials used for the thesis have been duly acknowledged.

Name: Dagnachew Kaleab

Signature ____________

Place of Submission: Demographic Training and Research Center, Institute of Development Research, Addis Ababa University.

Date of Submission: May, 1999